Summer Meeting Issue

SAE Journal

JULY 1955

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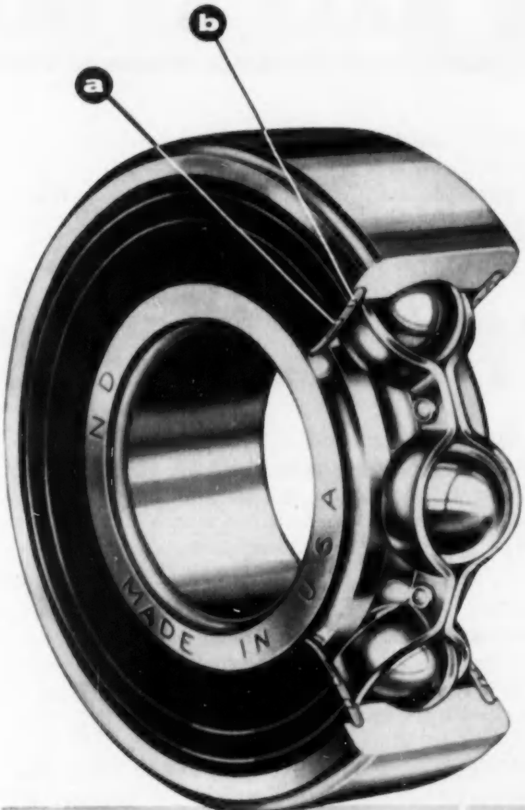
FACTS

about

NEW DEPARTURE
BALL BEARINGS



New Sentri-Seal...on guard against dirt and wear!

The unique design of the Sentri-Seal gives optimum protection against dirt, and includes a number of other major advantages.

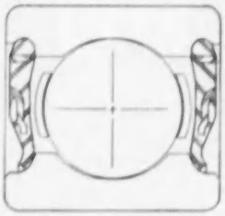
Sentri-Seals are quickly removed, easily replaced. As the seal is of synthetic rubber, in which two metal rings are embedded, a constant-rate spring is created between the rings. Inherent flexibility prevents distortion of the bearing outer ring due to seal insertion, permitting the use of bearings to the higher accuracy specifications. The spring action maintains an efficient sealing contact with the bearing ring to bar dirt and retain lubricant. Sentri-Seals are relatively inert to oils and greases and operate satisfactorily through a temperature range of −40°F to 225°F. Specifications available for still higher temperatures. In applications where relubrication is desired, it is easily accomplished by the injection method.

The New Departure Sentri-Seal basically consists of two separate metal rings, "A" and "B", embedded in synthetic rubber, resulting in a spring which absorbs distortion and deflection. The seal is not drastically influenced by axial displacement due to bearing end-play within prescribed tolerances, and provides efficient sealing at low torque. Bearing shown is equipped with two seals.

ONE SENTRI-SEAL | SEAL AND SHIELD | SEAL AND SNAP RING | TWO SEALS AND SNAP RING | SEAL, SHIELD AND SNAP RING

The diagram shows in section the New Departure Sentri-Seal. Lip contacting surfaces are form-ground simultaneously with the ball race, giving an extremely high degree of concentricity between sealing surfaces and the raceway.

Sentri-Seal is available for a range of sizes in single-row, standard-width bearings and also in two types of New Departure adapter bearings. Sizes, dimensions and capacities are listed in the latest New Departure catalog.



Write for full details on Sentri-Seal

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONN.

SAE JOURNAL, July, 1955, Vol. 63, No. 7. Published monthly except two issues in January by the Society of Automotive Engineers, Inc. Publication office, at 10 McGovern Ave., Lancaster, Pa. Editorial and advertising department at the headquarters of the Society, 29 West 39th Street, New York 18, N. Y. $1 per number; $10 per year; foreign $12 per year; to members 50 cents per number, $5 per year. Entered as second class matter, September 15, 1948 at the Post Office at Lancaster, Pa., under the act of August 24, 1912. Acceptance for mailing at special rate of postage provided for in the Act of February 28, 1925, embodied in paragraph (d-2), Sec. 34.40, P. L. and R., of 1948. Additional entry at New York, N. Y.

sealed **TIGHT,**
sealed **RIGHT,**
with a
Precision "O" Ring!

...this Atlas Reducing Valve

Atlas Fig. 191—Type "E" Reducing Valve

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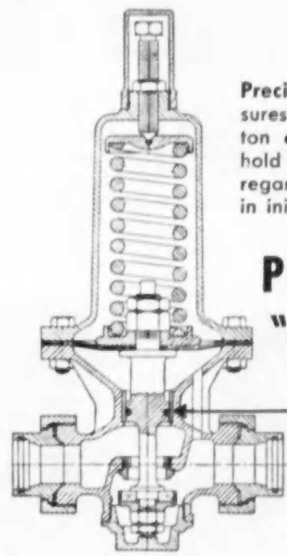
How about your sealing problem? Let our engineers help you solve it with **Precision** "O" Rings—tough, compression molded, rigidly inspected — finest "O" Rings made!

FREE—Handbook of "O" Ring data.
Write for yours today.



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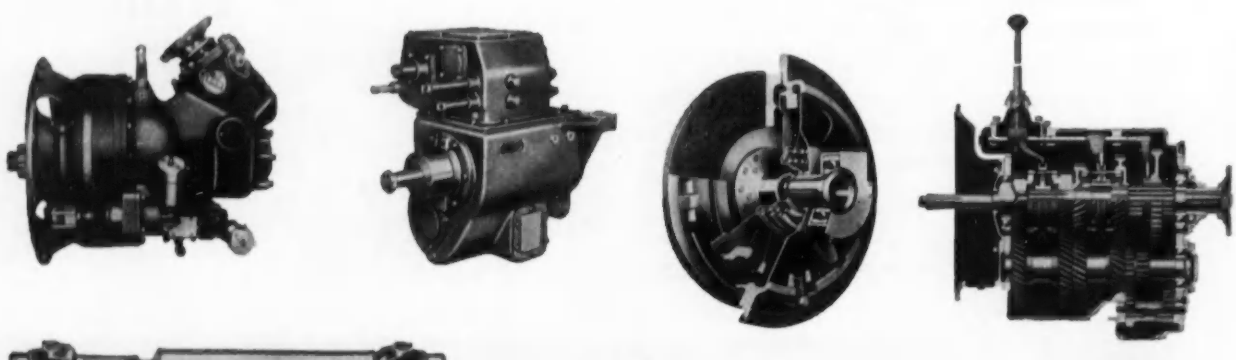

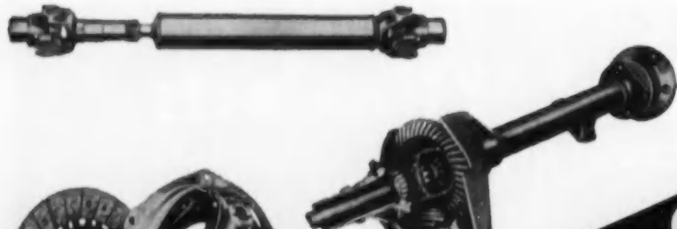

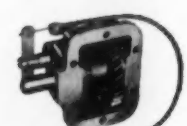

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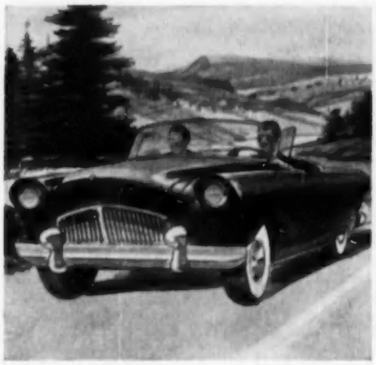

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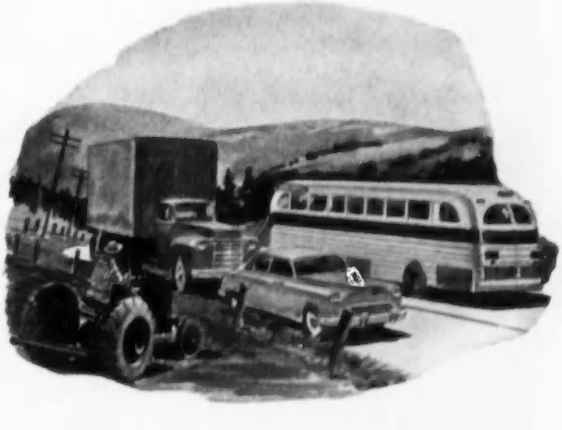

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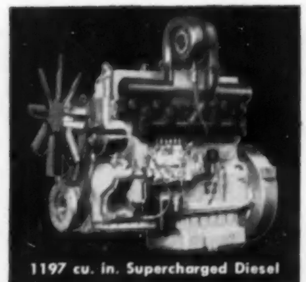
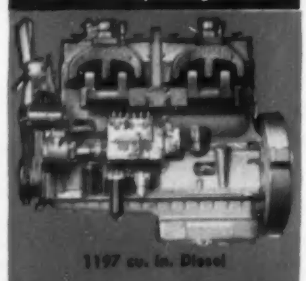
MODEL	Cyl.	*Features	Bore and Stroke	Displ. Cu. In.	Max. Torque @ RPM	Max. HP	RPM
TURBO-SUPERCHARGED DIESELS							
135-DKBS	6	ACTV	4¼x5	426	400-1800	185	2800
148-DKBS	6	ACTV	5¼x6	779	706-1800	280	2100
WAKDBS	6	ACTV	6¼x6½	1197	1062-1600	352	1800
NORMAL DIESELS							
185-DLC	6	A	3½x3¾	216	152-1200	60	2400
190-DLCA	6	AC	3¾x4	265	191-1400	85	2800
195-DLCA	6	AC	4 x4	302	221-1800	98	2800
135-DKB	6	ACV	4¼x5	426	328-1600	147	2800
148-DKB	6	ACV	5¼x6	779	584-1000	200	2100
WAKDB	6	ACV	6¼x6½	1197	845-1000	258	1800
GASOLINE							
185-GLB	6	A	3½x3¾	216	176-1400	67	2400
190-GLB	6	A	3¾x4	265	220-1200	77	2400
195-GKA	6	ACV	4⅛x4	320	243-1600	122	3000†
MZA	6	A	4¼x4¾	404	289-1000	128	2800†
135-GKB	6	ACV	4¼x5	426	337-1200	147	2800†
135-GZB	6	ACV	4⅜x5	451	354-1200	153	2800†
140-GKB	6	ACV	4½x5½	525	425-1000	177	2600†
140-GZB	6	ACV	4⅝x5½	554	448-1100	188	2600†
145-GKB	6	ACV	5¼x6	779	595-1000	240	2400†
145-GZB	6	ACV	5⅜x6	817	630-1100	250	2400†
WAKB	6	ACV	6¼x6½	1197	1000-1000	280	1800

***FEATURES:** A—Aluminum Alloy Pistons; C—Counterbalanced Crankshaft; T—Turbo-Supercharged; V—Vibration Dampner.

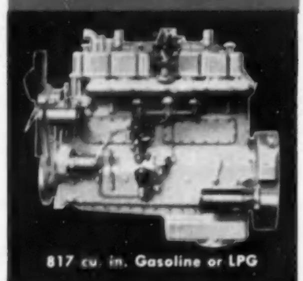
†These engines rated at higher hp and rpm for fire engine service. *Send for Bulletin 1079 for LPG ratings and complete listing of engine hp and speed ratings.*



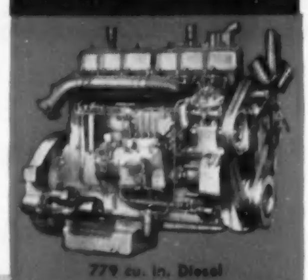
1197 cu. in. Supercharged Diesel



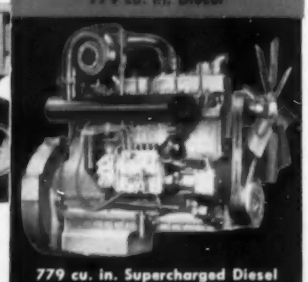
1197 cu. in. Diesel



817 cu. in. Gasoline or LPG

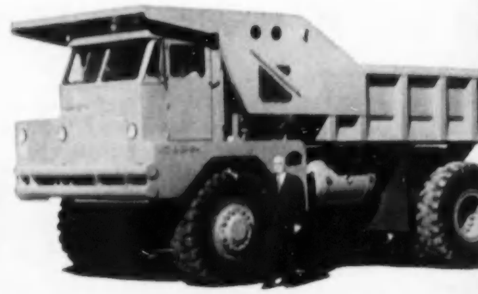


779 cu. in. Diesel



779 cu. in. Supercharged Diesel

280



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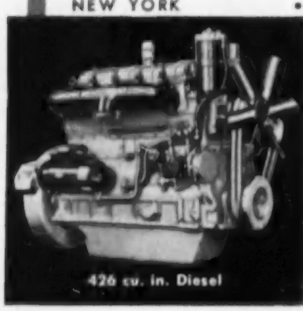
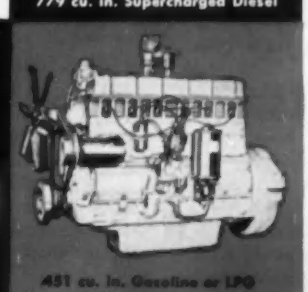


426 cu. in. Diesel

426 cu. in. Supercharged Diesel

554 cu. in. Gasoline or LPG



451 cu. in. Gasoline or LPG

Klixon CDM-30 amp. weatherproof circuit breaker provides circuit protection for Caterpillar D8 Tractors.

Installation of the Klixon CDLM-40 amp. weatherproof protector in the Caterpillar DW20.

For the Sake of Argument

A Young Man Tells the Boss

By Norman G. Shidle

"A supervisor can never afford the luxury of subjective reactions. Isn't that what you're trying to say?"

The inquirer was a young man about to be given his first supervisory job. His sudden summary capped a quarter-hour of rambling advice from his boss. (The young man was exercising perfectly what Upson's Alexander Botts calls "the higher discipline" . . . doing what the boss would have told you to do if he had known what he was talking about.)

"That's exactly right," his boss started rambling again. "You must always think first of your subordinate's reactions before you are entitled to have one yourself. . . . And, by that time, you are usually able to think instead of just reacting.

"But, you mustn't fall into the trap of thinking of his subjective reaction either. What interests you is the probable effect of his personal reaction on the work at hand.

"What you say or do should steer or bounce his mind to greater or clearer activity in the general direction of job accomplishment. It should direct his attention to some problem you are facing mutually. It should stir him to more interest in getting right action; never divert him to personal feeling—good or bad—about his relationship to you. But the truth must be stated attractively . . . so your associates will wish to have more of it . . . will pick it up and take it away.

"Your response to any approach is never best stated as an answer to the question: 'Who is right and who is wrong?' In fact, you'll hardly ever go wrong thinking in terms of principles rather than people."

The boss finally ran down. The young man thanked him eagerly . . . and went out saying to himself:

"What he's saying is that a superior can't ever afford the luxury of a subjective reaction."

SAE Journal

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Editor

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Managing Editor

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1905 SAE GOLDEN ANNIVERSARY 1955

Contents—July, 1955

1905 GOLDEN ANNIVERSARY 1955

SUMMER MEETING

THE COMPLETE STORY of SAE Summer Meeting (June 12-17) starts on **PAGE 70.**

Techniques for Improving

COMMUNICATIONS in many companies is one of the weak links between a management and its employees.

Communication difficulties exist in most other units of the organization. But in the factory area they appear most frequently. This is usually because of:

(a) the number of people involved,

(b) the supposed differences in their interests,

(c) their distance from the executive level, and

(d) the need for their work to integrate closely with that of Sales, Engineering, Accounting, and Administration.

Important contributing factors involved in effective communications include:

1. Remember that effective communications represents an interchange of thought and information both upward and downward in the organization's channels.

Many people spend more time communicating than in any other activity. Despite this they frequently fail to concentrate sufficiently to fully understand what they are being told or to be certain that what they are saying is fully understood. Orders and instructions not only must be given, but must be received and understood. Employees must understand and their desires must be understood.

2. Communications always involve at least two people. And the participants are people who like to be considered as human beings. An effective administrator must be able to perceive the reactions of people he is listening to and talking with.

The big problem is to widen the perceptions of people, help them to obtain a broad conception of the entire organization problem, and assist them in thinking in terms of the whole.

3. The informal channels of communication may become blocked. Then, without the assistance of the informal, the formal channels break down.

4. The higher one goes in an organization the more difficult the problem of effective communications becomes to the lower levels.

5. The difficulties of language, semantics and clearly saying what is meant frequently hamper effective communication. People who are listening frequently have to work at figuring out whether what is being said is really meant or whether something else is intended.

6. Most people in the organization understand things better if they are expressed in terms of specifics and examples rather than in terms of principles. This is important to keep in mind.

Emphasis on People

It is important to notice the emphasis on people, their hopes, desires and understanding. Direct quotes taken at random during this Forum discussion illustrate this point.

1. "Policy manual and directives are too often one way streets."
2. "Management writes a book and tries to let the book and system do the job instead of doing it through and with people."
3. "Sometimes people at the top are not careful enough of their words. They say things that are taken as gospel truth down the line."
4. "Foremen or assistant foremen don't know what their jobs really are. They have never been properly and clearly told."
5. "Problem of too many conferences—trying to decide things that ought to be decided by one man."

The person who might be most at fault is the boss, according to several discussors—some of whom are bosses. The importance of the boss considering the possibility he might be at fault in communications

Factory Communications

J. M. Phelan, A. T. Kearney Co.

Based on secretary's report of Panel on Techniques For Improving Factory Communications held as part of the SAE Production Forum at the SAE Golden Anniversary Aeronautic Meeting, New York, April 21, 1955.

was pointed out. One man quoted: "When the fish gets old and begins to smell, the odor starts at the head."

To eliminate communication difficulties, various remedial steps may be used. Some suggested at this meeting were:

1. Great assistance can come from a better understanding of the problem and of the various and most effective techniques.

2. One of the best ways is to have a good group relationship which means you need to get through to your people and establish common understanding.

3. Let the decisions be made at the lowest possible level in the organization.

4. It is very helpful to talk cases and specific examples instead of principles.

5. You must recognize that communications is a two way street.

6. It is important to remember that communications means dealing with people.

7. It is important to express yourself clearly, to be sure you are understood, and even more important to be sure you understand the other fellow.

8. There is frequently great need to get closer to your people. Shorten the communications line and eliminate levels in organization which hamper communications. Make people feel they have an important part and give recognition for a job well done.

9. Techniques such as meetings, bulletins, letters, procedure and policy manuals are all helpful but are not a substitute for real understanding and willingness to listen.

10. Physically moving people together from separate departments actually improves communications and shortens the punch. This is particularly effective in design or redesign of new products or revisions of old products.

11. There is a need to strike a proper balance between engineering and manufacturing departments on engineering changes and revisions.

If one salient point stands out in the discussion, it is this:

"Remember that communications means people, their understanding and failure to accept or understand. Explain things clearly and give them time for mental digestion."

(The report on which this article is based is available in full in multilith form together with reports of six other panel sessions of the 1955 SAE Production Forum held at the SAE Golden Anniversary Aeronautic Meeting, New York, April 21, 1955. This publication, SP-311, is available from SAE Special Publications Department. Price: $1.50 to members, $3.00 to nonmembers.)

A. S. Krotz, B. F. Goodrich Co.
J. H. Kramer, B. F. Goodrich Co.
R. E. Houser, Flxible Co.

Based on paper "Self Leveling Torsilastic Suspension" presented at the SAE Golden Anniversary Annual Meeting, Detroit, Jan. 14, 1955.

Rubber Springs Require

Self-leveling torsilastic suspension proves practical on large vehicles

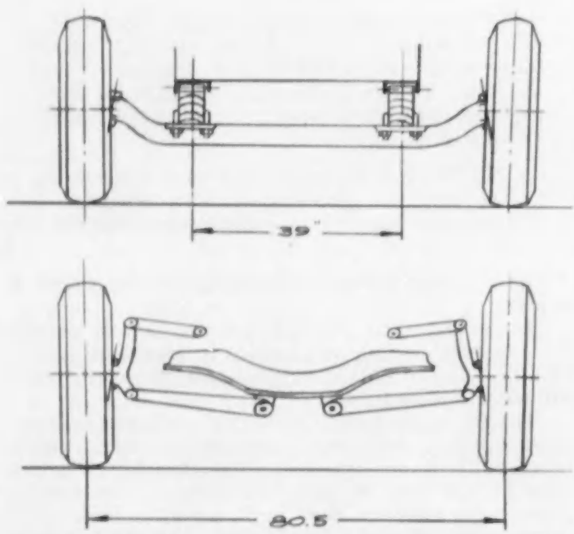

Fig. 1—Conventional leaf spring suspension is spaced approximately 39 in. apart. Independent suspension system gives effect of 80.5 in. spacing, and 4 times the roll stability

IN designing a rubber spring suspension system for a large bus, it was found that a constant level device was needed. This provides a softer ride through more flexible springs, and increased safety through a high resistance to roll. Let's consider, first, the problem of roll.

Resistance to Roll is High

Resistance to roll varies directly as the square of the transverse distance between the springs of a suspension system.

A conventional front axle for a 45-passenger, intercity bus, will have the leaf spring pads spaced approximately 39 in. apart, as shown in Fig. 1. (They may be even closer together if 45 deg inside steering lock and 11.00-22 tires are used.)

An independent suspension system, gives the effect of placing the springs in the wheel track plane which is 80.5 in. apart. Calculations show that with identical wheel rates, the independent suspension produces four times the roll stability.

At the rear axle, (Fig. 2) the outer shells of rubber torsion springs are mounted on the axle housing, and the spring shaft carries a torque arm at each end of the spring which is shackled to the body structure.

The distance between the outer ends of the torque arms is 61.5 in. The widest practical spacing of other spring suspensions would be only 36 in. Therefore, with identical spring rates, the torsilastic suspension gives 2.9 times as much roll control as would have been possible with conventional leaf springs.

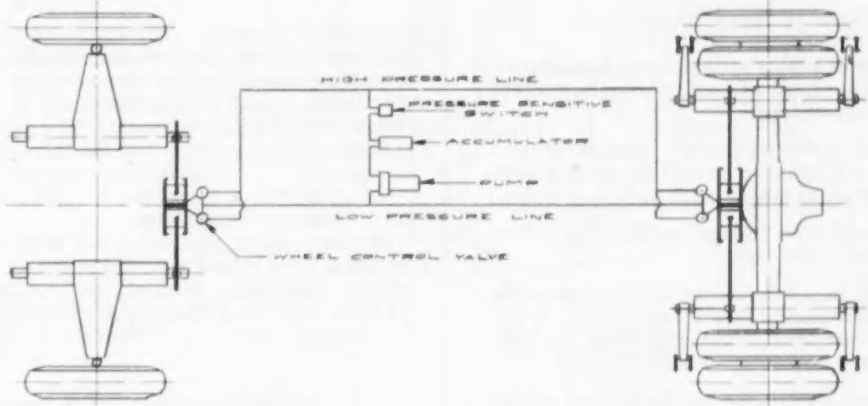

Fig. 3—Schematic of the constant level device used in the 2-level, intercity bus, showing pumps and fluid lines

Constant Level Device

Since the inherent roll resistance of this system is so high, spring softness can be determined from the maximum wheel stroke, without worrying about excessive roll.

Springs Are Softer Than Usual

A large wheel stroke permits the use of springs with soft rates. So, total wheel "breathing action" was set at 12 in., with bumpers meeting at least 1.5 in. before metal-to-metal contact.

It was decided to limit the maximum change in step height, loaded and unloaded, to 2.25 in. This left 9.75 in. (12.00-2.25 in.) for the entire dynamic wheel stroke. This will give 4.25 in. rebound from empty (2.75 in. to minimum bumper contact), and 5.5 in. compression from loaded (4.0 in. to minimum bumper contact).

The weight distribution of this bus was as follows:

	Front	Rear	Total
Gross Empty (lb)	6143	12558	18700
Unsprung (lb)	941	2147	3118
Sprung Empty (lb)	5172	10411	15582
Pay Load (lb)	2204	4270	6473
Per Cent Pay Load	34%	66%	100%

Since no more than 2.5 in. change in height with pay load was desired, and assuming that the spring rate is uniform, it was necessary to have 490 lb per in. for each front wheel and 950 lb per in. for each rear wheel. When divided into the sprung empty loads, this represents 5.3 in. nominal deflection in the front end and 5.35 in. for the rear.

It was desired to use rubber springs because of their lower noise level, reduced harshness and reduced maintenance. But rubber springs are dynamically somewhat stiffer than indicated by static deflections. For the type of spring and rubber under consideration this difference amounts to about 30%. That is, the springs were dynamically 130% of their static rate. Applying this ratio to the 5.3 in. nominal static deflection indicated that dynamically the deflection would be only 4.1 in.

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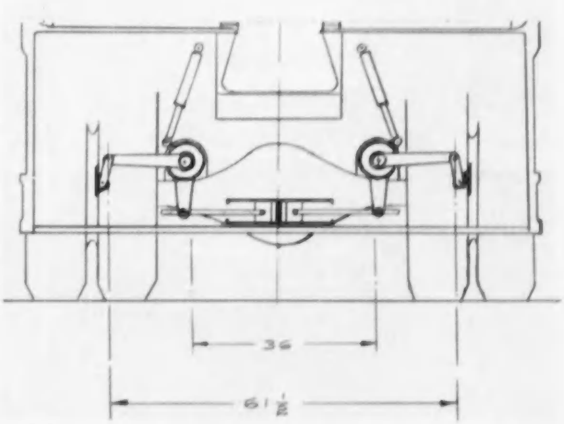


Fig. 2—In the rear, torsilastic suspension's wide spacing gives 2.9 times as much roll control as possible with conventional leaf springs

Rubber Springs Have Drawbacks

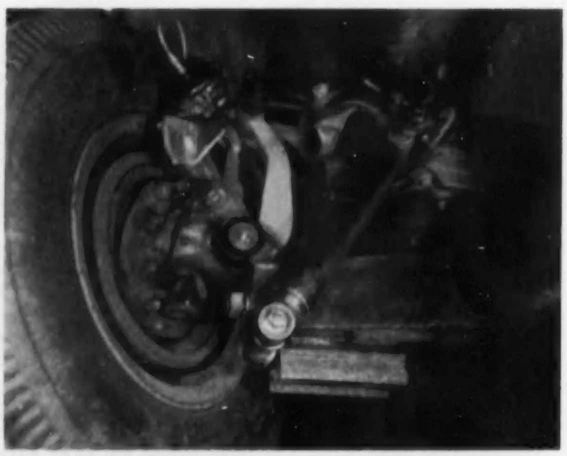
THE use of rubber springs is not exactly new, but it has not been adopted extensively because of certain drawbacks.

(1) Due to the Joule effect, changes in temperature will cause a vehicle suspended with rubber springs to vary as much as 51% in height.

(2) There is an inherent tendency of rubber to cold flow under load.

(3) The suspension system design requires the use of independently sprung rear wheels. In the passenger car field particularly there has been reluctance to make such a radical change.

For these reasons the development of rubber suspension systems has been limited primarily to use in buses, although recently there has been some activity in the military, trailer, truck, and railway fields.



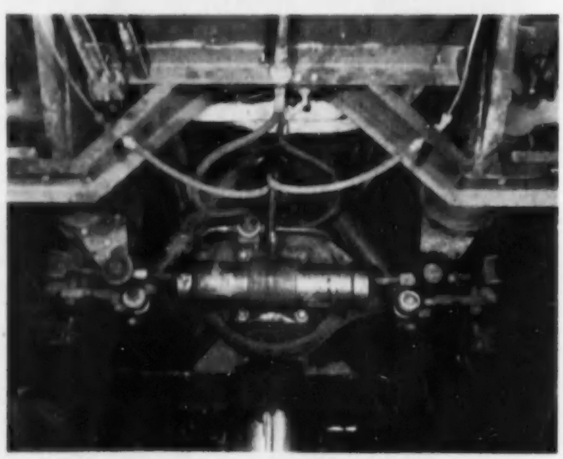


Fig. 4—Front springs weigh 83 lb each, including 21.2 lb of rubber; rear springs weigh 120 lb, including 33 lb of rubber

Using this in the equation $f = \frac{188}{\sqrt{d}}$ resulted in a theoretical verticle frequency of 92.5 per min. This was too stiff. The rear could be improved a little by taking advantage of the variable rate effect of the special suspension linkage, but in front no such improvement could be made. The greatest possible nominal dynamic deflection for the empty bus would be about 5.0 in. This was not enough, so a constant leveling device was necessary, particularly for the luxury class intercity bus.

Dynamic rates decided upon were 400 lb per in. for each front wheel and 700 lb per in. for each rear wheel. This gave dynamic deflections (empty) of 6.5 in. in front and 7.4 in. in the rear. Similar loaded deflections were 9.2 in. (front) and 10 in. (rear).

The Constant Level Device

A constant level device permits the reduction of spring rate, thereby giving a softer ride. A schematic of the system used in the intercity, two-level bus is shown in Fig. 3.

A pump and motor unit supply oil at a minimum pressure of 1500 psi. Storage capacity is 1 gal. The accumulator has a capacity of 1 pt. Approximately 100 cu in. of fluid is required to take the bus from completely empty to fully loaded. With a pump of 0.93 gpm capacity, the time lag from empty to load is approximately 30 sec.

The accumulator is primarily a means of preventing pressure drop due to leakages. It also reduces the cycling of the pressure sensitive switch which controls the operations of the pump motor.

The hydraulic pistons controlling the two front or the two rear wheels are assembled in one central cylinder casting, but each wheel operates separately. The position of each wheel spring is controlled by one of the pistons.

Oil is passed in or out of the cylinder by a valve linked to the wheel. As load increases, the wheel tends to lift, relative to the chassis, and open the high pressure connection to the cylinder. As load decreases, the low pressure valve is opened. To avoid cycling due to action on the road, each valve is dampened hydraulically to require a time lag before it will change position.

The front wheel geometry was laid out to give virtually zero change in track throughout the wheel stroke, although very little change in camber was necessary. The front and rear suspension assembly is shown in Fig. 4.

The front springs for this design weighed 83 lb each including 21.2 lb of rubber while the rear springs weighed 120 lb including 33 lb of rubber. These weights do not include housings, arms and related parts. Indications are that there might be some advantage in weight as compared with more conventional suspensions.

Actual road tests on this bus with self-leveling torsilastic suspension were very satisfactory. Noise level, harshness, and shake were very low; the bus handles extremely well during cornering, on smooth and rough roads, and throughout the speed range.

Paper on which this abridgment is based is available in full, in multilith form from SAE Special Publications Department. Price: 35¢ to members, nonmembers 60¢.

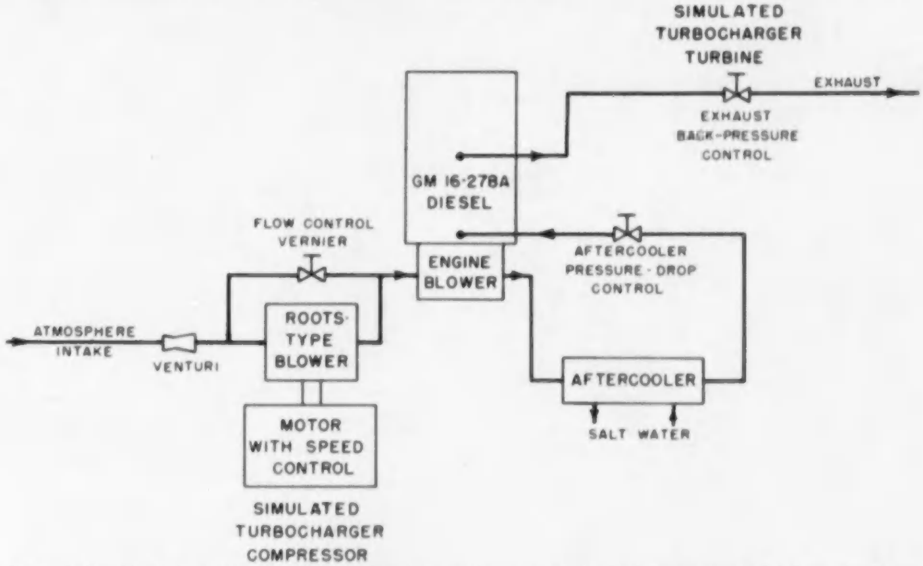


Fig. 1—Schematic of the system used to simulate turbosupercharger operation in determining engine air requirements.

U. S. Naval Engineering Experiment Station Investigates

Turbosupercharging the 2-Stroke Diesel Engine—Part II

W. G. Payne and W. S. Lang,
U. S. Naval Engineering Experiment Station

Based on paper "High Supercharging Development of a GM 16-278A 2-Stroke Cycle Diesel Engine," presented at the SAE National Diesel Engine Meeting, Cleveland, Oct. 27, 1954. This paper will be published in 1955 SAE Transactions.

2-Stroke Cycle Diesel Engine (GM 16-278A) is adapted for turbosupercharging

THEORETICALLY the output of the General Motors 2-stroke cycle diesel engine (model 16-278A) can be increased from 1600 to 3000 bhp at 750 rpm by compounding it with a turbocharger, Roots-type blower, and aftercooler. And, by using a device to control engine compression ratio, thermal efficiency at lower loads can be improved.

Tests with a simulated turbocharged installation —at the U. S. Naval Engineering Experiment Station, Annapolis,—proved that the paper-analysis was accurate. Fig. 1 is a schematic diagram of the installation. Also, thermal efficiency from 1500 to 3000 bhp was better than that at the engine's original 1600 bhp rating. Further tests are now underway adapting turbochargers to the engine and developing the manifolding to duplicate the simulated turbocharged operation.

The GM 16-278A was selected for the investiga-

	Data \ Engine system	STANDARD ENGINE TIMING					CONTROLLED EXHAUST CLOSURE TIMING												
		STANDARD EQUIPMENT	AFTERCOOLER	LARGER MECH BLOWER-AFTERCOOLER	STD MECH BLOWER-TURBOCHARGER-AFTERCOOLER	TURBOCHARGER-STD MECH BLOWER-AFTERCOOLER	LARGER MECH BLOWER-AFTERCOOLER		STD MECH BLOWER-TURBOCHARGER-AFTERCOOLER		STD MECH BLOWER-INTERCOOLER-TURBOCHARGER-AFTERCOOLER		TURBOCHARGER-STD MECH BLOWER-AFTERCOOLER		TURBOCHARGER-INTERCOOLER-STD MECH BLOWER-AFTERCOOLER		SNORKEL: TURBOCHARGER-STD MECH BLOWER-AFTERCOOLER	TURBOCHARGER AFTERCOOLER	
CONTROLLED CONDITIONS	SCAVENGE AIR TEMP, °F	140	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
	SCAVENGE AIR PRESS, psig	3.00	2.90	11.00	11.00	11.00	16.70	16.70	16.70	16.70	16.70	16.70	16.70	16.70	16.70	16.70	14.45	16.70	16.70
	CYLINDER COMPRESSION TEMP, °F	1145	1038	959	1050	1010	772	885	830	950	830	950	792	909	780	895	972	796	910
	CYLINDER COMPRESSION PRESS, psig	594	591	850	850	850	600	850	600	850	600	850	600	850	600	850	850	600	850
	EXHAUST CLOSE °BTC	121.5	121.5	121.5	121.5	121.5	71.3	98	71.3	98	71.3	98	71.3	98	71.3	98	104.7	71.3	98
	EFFECTIVE COMP RATIO	13.51	13.51	13.51	13.51	13.51	9.06	11.62	9.06	11.62	9.06	11.62	9.06	11.62	9.06	11.62	12.35	9.06	11.62
OPERATING CONDITIONS	INTAKE AIR TEMP, °F	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
	INTAKE AIR PRESS, in.hg	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-3.0	-1.0	-1.0
	CYLINDER CHARGE TEMP, °F	181	141	110	146	130	110	110	137	137	137	137	120	120	114	114	134	121	121
	CYLINDER CHARGE PRESS, psig	3.0	2.9	11.0	11.0	11.0	16.7	16.7	16.7	16.7	16.7	16.7	16.7	16.7	16.7	16.7	14.45	16.7	16.7
	INLET PORTS OPEN, °ATC	129	129	129	129	129	129	129	129	129	129	129	129	129	129	129	129	129	129
	INLET PORTS CLOSE, °ATC	129	129	129	129	129	129	129	129	129	129	129	129	129	129	129	129	129	129
	EXHAUST OPEN, °ATC	89	89	89	89	89	89	89	89	89	89	89	89	89	89	89	89	89	89
	ENGINE BACK PRESS, psig	1.40	1.50	4.80	9.38	9.10	7.65	7.65	15.08	15.08	15.09	15.09	13.50	13.50	12.50	12.50	12.60	13.90	13.90
CALCULATIONS	VOL AIR DELIVERED-CFM at STP	5229	5159	10763	5569	6180	13235	13235	5555	5555	5520	5520	7687	7687	8722	8722	5868	7430	7430
	VOL DELIVERED/VOL DISPL	1.191	1.180	2.450	1.270	1.410	3.020	3.020	1.265	1.265	1.260	1.260	1.754	1.754	1.990	1.990	1.340	1.695	1.695
	VOL RETAINED/VOL DELIVERED	.675	.721	.601	.950	.980	.403	.517	.818	*	.823	*	.646	.828	.587	.754	.993	.661	.852
	RELATIVE CHARGE	0.944	1.000	1.732	1.418	1.620	1.430	1.830	1.219	*	1.219	*	1.330	1.705	1.371	1.760	1.561	1.315	1.695
RESULTS	GROSS OUTPUT, HP	1742	1848	3200	2615	2990	2670	3380	2250	*	2250	*	2455	3145	2535	3250	2880	2425	3130
	BLOWER LOAD, HP	158	170	671	121	125	1132	1133	125	*	136	*	207	207	250	250	328	0	0
	NET OUTPUT, BHP	1584	1678	2529	2494	2865	1538	2247	2125	*	2115	*	2248	2938	2285	3000	2552	2425	3130
	GROSS BMEP, psi	91.2	96.5	167.5	136.8	156.5	138.1	176.9	117.8	*	117.8	*	128.3	164.8	136.7	170.0	150.8	127.0	163.8
	NET BMEP, psi	82.9	87.6	132.3	130.5	150.0	80.4	117.5	111.2	*	110.6	*	117.5	153.3	119.7	157.0	133.5	127.0	163.8
	FUEL CONS, lb/bhp-hr	.405	.403	.466	.386	.383	.640	.553	.390	*	.393	*	.402	.395	.408	.400	.415	.368	.368

* NOT PRACTICAL, INSUFFICIENT AIR DELIVERY FOR COMPRESSION CONDITIONS

Fig. 2—Various supercharging systems were analysed and their performance was predicted as tabulated.

tion because the Navy owns more of this model than any other larger engine. It has an 8.75-in. bore and a 10.5-in. stroke. Operating at 750 rpm it has been rated at 1600 bhp for submarine and most other types of service. Maximum rating is 83.6 to 88.9 psi bmep. Specific weight, dry with attached accessories, is 19.4 lb per hp, and specific bulk is 0.29 cu ft per hp.

After certain desirable constants were decided upon, such as keeping the engine at its present 750 rpm rated speed, keeping intake port and exhaust valve areas unchanged, and keeping the existing Roots blower, a preliminary analysis was made.

For example, it was calculated that adding an aftercooler to the standard engine would give a denser cylinder charge at very little expense to blower horsepower, and increase net output only 94 bhp. Also, an exhaust-driven blower, used as a first-stage compressor in series with the engine-driven Roots blower, would permit full use of the exhaust energy for boosting pressure.

Thirty-seven different combinations of air system components were analysed. The results of 18 of these air systems are tabulated in Fig. 2.

These data showed that a variable-compression-ratio system could be used to obtain about 100 bhp greater maximum output with similar limits of operating conditions. It would provide better operating economy over a wider range of loads. It would make possible increased output under submarine snorkel conditions. It would have the disadvantage of adding a complicated mechanism to the engine.

High pressure supercharging (either with fixed or variable timing) would permit net bhp to be increased from the present 1600 or 1700 bhp at 750 rpm to about 3000 bhp at the same speed. This is an increase of about 80%, and thermal efficiency would remain as good as at the lower rating. Using these data as guide-posts, the Navy began actual laboratory experiments. The following questions had to be answered:

1. What operating conditions will best provide the exhaust energy for driving the turbosupercharger?

2. Is there a turbosupercharger currently being manufactured with size and characteristics which will match the requirements of the engine under those operating conditions?

3. How can manifolding be modified to drive the turbocharger with the maximum efficiency without causing detrimental back pressure on the engine?

4. What is the most suitable air flow and air pressure to satisfy combustion chamber requirements for scavenging and charging?

5. What type of air manifolding should be used to transmit the air to the cylinders with the least pressure loss?

The project was divided into two phases. First, turbocharger action was simulated to determine engine operating characteristics. Then, these characteristics were used as specifications for procuring and matching commercial turbochargers and designing the manifolding.

This is Part II of a two-part article. Part I appeared in the June, 1955 issue of SAE Journal.

Turbocharger installation is simulated

Air from a laboratory supply was piped to the engine as shown in Fig. 1. The simulated system included a valve in the exhaust line to give exhaust back pressures in the ranges that would be caused by existing turbochargers. A motor-driven variable-speed, Roots-type blower was installed in the intake line as a first-stage compressor to take the place of the turbocharge compressor. A salt-water cooled, tubular aftercooler was used.

Considerable improvement in output was made possible by making slight changes in the air and fuel systems. For example, the fuel injector nozzle orifice was enlarged 70%, camshaft timing was retarded, and compression ratio was reduced. Performance correlated well with that predicted in the analysis.

The tests proved that the engine was capable of developing 3000 bhp and at the same time improving thermal efficiency over that achieved at the original 1600 bhp. A net bmep of 157 psi is possible.

Before this output can be achieved in commercial practice, however, it is necessary to find an exhaust-driven turbocharger which matches the engine. The exhaust energy present at the engine must be fed through the turbine without undue energy loss and the compressed air must be delivered to the engine equally efficiently. The turbocharger must meet the airflow requirements with at least 62% efficiency.

Existing turbochargers are not efficient enough

Using the data obtained in the simulated turbocharger tests as criteria, the Navy looked over the current market for a turbosupercharger suitable for compounding with this diesel engine. Three different turbosuperchargers have been selected as prospects and engine tests begun.

Preliminary tests were made with the same fixed 13/1 compression ratios, fuel injector spray tips, and standard timing that were used for the simulated turbocharger tests.

Discussion

Full and detailed discussion by the following authors will be published with this paper in 1955 SAE Transactions:

C. A. Chamberlain,
Clark Brothers, Co.

Rudolph Birmann,
De Laval Steam Turbine Co.

R. F. Miaskiewicz,
Turbocharger Division, Elliott Co.

C. F. Taylor,
Massachusetts Institute of Technology

A. K. Antonsen, and E. L. Dahlund,
Fairbanks, Morse & Co.

Fig. 3 shows the results using multiple-exhaust manifolding (dashed curves) and afterwards, a common-exhaust manifold (solid curves). Turbocharger efficiency was below that expected, probably because the ports opened at a time when scavenging flow was too easy and there was incomplete scavenging.

Adapting the turbosuperchargers to the engine and experimenting with the manifolding will continue until the three turbocharger designs have had an opportunity to show their best efficiency. It is expected that operation will then match the thermal efficiency shown during the simulated turbocharged operation at the peak load of 3000 bhp. Thermal efficiency may be somewhat inferior at the lower loads because the turbocharger efficiency is likely to decrease at lower gas flows.

(Paper on which this abridgment is based is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

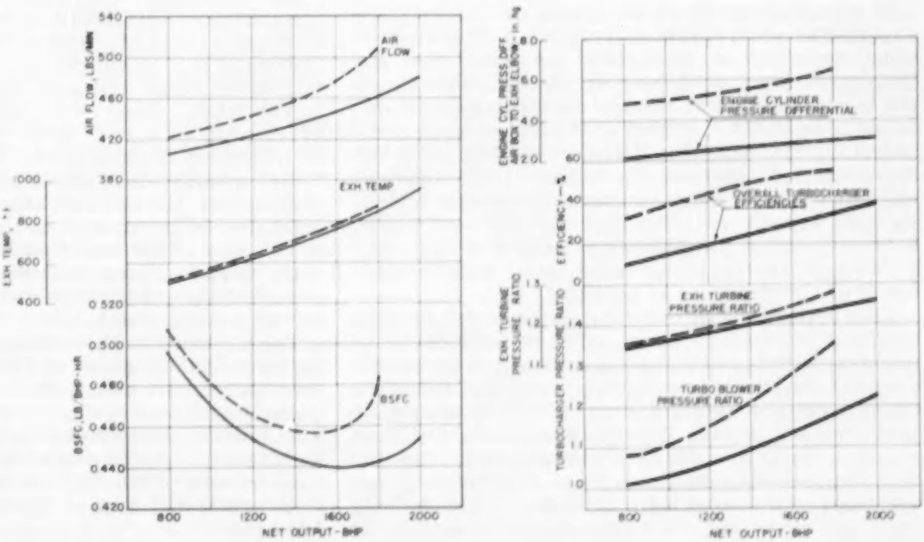


Fig. 3—While using an actual turbocharger the above operational data were obtained. Compression ratio was 13/1. Timing was standard. Dashed curves are data obtained using a multiple-exhaust, 3.75-in. manifolding. Solid curves represent common-exhaust manifold.

Production Plan Speeds Aircraft

RECENTLY, Convair, Hughes, and AMC developed a plan to define the respective interests and responsibilities of both airframe and equipment manufacturers, when both are prime contractors. Although developed to cover the installation and operation of a fire control system in an interceptor, the plan generally reflects the considerations and methods desirable for similar tasks.

Specifically, the prime objectives of the plan were to define:

1. The responsibilities of the two contractors.
2. Method of operation.
3. Personnel and training provisions.
4. Provision for test equipment and facilities.

Responsibilities

The assignment of responsibility argues that a dual role exists at the aircraft manufacturer's plant during the early production period. The operational problems in this phase can stem from the equipment, the installation, or the skill with which the task is performed. Since the equipment manufacturer is the recognized authority on equipment operation, it is desirable that he should be given the opportunity to discover the nature of the difficulty without the issue being confused by possible lack of skill or experience. Yet the aircraft contractor, held responsible for delivery schedules of the overall weapon, should, at all times, be as fully in command of the situation as possible.

This apparent contradiction in aims can be successfully resolved by the manner of assignment of responsibilities to the two contractors. This can be done by establishing an initial quantity of airplanes considered a maximum over which development problems will occur. For these aircraft, the plan consigns to the equipment manufacturer "up to" full responsibility for operational performance. At any time prior to that point (and the earlier the better), the production task may be established to be routine, as shown by repetitive operations free from design modifications, deviation of test procedures, or inordinate attrition. Whenever this occurs, the aircraft manufacturer should assume the task and stand or fall on his own merits.

Method of Operation

The method of operation also reflects the dual nature of the task. It calls for an initially conservative and repetitive type of operation until the equipment, task, and organization have been shaken down and stabilized. As experience is gained, the plan calls for conversion to ultimate methods which are more direct and efficient. There was a time when these proposed operations would have been labelled revolutionary. For example, the objective to eliminate the bench check was quite controversial a short time ago but is now generally accepted by the industry; that specification in this plan becomes a conventional one. Worthy of note, however, is the expressed testing philosophy, as it goes back beyond the bench check and into the electronic manufacturer's plant. Some of the same arguments against bench checking have been applied to the initial manufacture of equipment. In short, obtain reliability, quality, and performance not by repeated checks that just add operational time on the equipment, but by better tests at the most effective point, in this case at the lowest operating levels, beginning with receiving tests on simple components. And once having qualified an item, circuit, or unit, do not repeat the check unless it is essential to do so.

The ultimate in this philosophy are tolerances so well established, parts so reliable, and methods so predictable that minimum operation with no repetition is achieved—even to the extent of eliminating a complete system checkout at the equipment manufacturer's plant and performing it one time only, in the airplane. This may not be practical today, but it is provided for as a distinct possibility in this joint plan.

Electronics Program

W. C. Urlovic, Northrop Aircraft, Inc.

Excerpts from secretary's report of Panel on Electronics, which was part of the SAE Aircraft Production Forum, Los Angeles, Oct. 6, 1954.

Personnel and Training

The third consideration, personnel and training, is probably the most conventional of any of the requirements, and its very trite nature is its greatest weakness. The importance of adequate training in advance cannot be over-emphasized for an aircraft electronics factory task involving complex armament equipment. It is a sad historical fact that the training requirement is all too often inadequately provided for in this area where each new contract requires almost a complete retraining of personnel to acquaint them with the particular characteristics of the new system to be installed. Even with adequate training provisions, factory supervision must be constantly alert and adept in their selection of personnel. Not only is lengthy experience a growing necessity, but the innate abilities of the man as a trouble-shooter are all-important. Gone are the days when the factory employee can be hired "off the street" and given a task to perform that he can "learn as he goes."

Personnel provisions are one consideration that must not only be planned but executed ahead of the normally recognized production task. In our plan, the specification for personnel and training is the one place where operations against the plan can be checked, and in fact, training is proceeding close to the actual requirements of the plan. With some months still remaining before the installation task is to begin on the first airplane, there is a growing confidence on the part of both contractors that the program is getting under way properly. This confidence is highest among the trainees and in the factory—those who must, in the end, write the final chapter. Such confidence is an extra dividend not specified by the plan. These intangibles of mutual respect, understanding, and cooperation are fundamental to a soundly executed program; although, sometimes only the line supervisor who must answer for the results values them properly. People are everything!

Test Equipment and Facilities

The last consideration, test equipment and facilities, is a straightforward problem of "no tickee, no laundly," and is manifest primarily as a problem in lead time. In electronics, test equipment is the tooling by which the job is done; its importance is all too often not understood by the many hands that must pass on some phase of its course to the user's plant. Where such equipment is special purpose, the problem of establishing early logistic support can be especially acute, with resolution often dependent upon the early definition of requirements, which a properly conceived plan can provide. The provision of facilities, on the other hand, can involve more than a simple review of the airframe manufacturer's resources if the task and the working requirements of both contractors are to be adequately considered.

Preparation of Plan

For those about to undertake a similar venture, a few words about the preparation of this joint plan may be helpful. First, before any detailed discussion was undertaken, certain principles, objectives, and ground rules were mutually determined between the two contractors and the customer. This established a common ground and assured a positive direction for the subsequent planning effort. Second,

THE Panel on Electronics, which discussed the production plan described here, consisted of the following:

Leader: H. J. Swartz,
Northrop Aircraft, Inc.

Coleader: F. B. Kemper,
Convair Division, General Dynamics Corp.

Secretary, W. C. Urlovic,
Northrop Aircraft, Inc.

Panel Members: C. F. Breitwieser,
Lear Inc.

L. L. Galloway,
North American Aviation, Inc.

L. N. Welch,
Boeing Airplane Co.

T. W. Wells,
Hughes Aircraft Co.

Guest Speakers: W. B. Plasse,
Rohrer, Hibler, and Replogle

H. L. Ellsworth,
Convair Division, General Dynamics Corp.

emphasis was placed on particular program characteristics and background. Every electronics task, like every airplane, has its individuality which must be properly noted if methods are to be realistic. Third, a mutual plan must be willingly prepared and supported by all parties concerned. In this particular joint plan, the AMC joint project office assumed the initiative throughout the first planning phase, during which principles and objectives were established. The smoothness of subsequent negotiations and much of any real merit contained by the plan as finally approved is a direct commendation of this early effort. This joint plan is not the same as it would have been, had a single party produced it individually. It is a compromise of interests and the better a plan for it. Like any other planning oversight, compromises made late can only adversely affect a program.

Finally, planning is not a place to expound theory but to reflect experience. It must use the management skills already developed, and be participated in by those who are to assume responsibility in the future. When completed, the plan and the task should be turned over to the line organization for execution without strings. A conditional plan reflects a task poorly defined or inadequately planned. The moral of this presentation can be expressed by an old analogy: Build your house on a firm foundation—a rather obvious piece of advice. Less obvious in the industrial process is the necessity of laying that foundation in advance—often in the form of sound planning.

(In addition to describing the production plan in support of an aircraft electronics program, as outlined in this article, the report of this production panel also covers the following topics:

1. Selection of electronics personnel.
2. Advantages and disadvantages of GFAE supply over CFE supply.

The full text of this report, together with the nine reports of the other panels of this Production Forum, is available from SAE Special Publications Department, as SP-309. Price: $2 to members, $4 to nonmembers.)

Convertible Aircraft . . .

. . . would make city-center landings feasible, thus flights of 100 miles or more between main metropolitan districts would become practical. The military will need such aircraft, too, in an atomic war.

Based on paper by **E. Burke Wilford,** Pennsylvania Aircraft Corp.

THE amount of time spent in getting to and from airports in big cities, plus the time spent in loading and ground taxiing, put airline flying at a great disadvantage. Between Philadelphia and Chicago, for example, this wasted time is just about equal to the actual time spent in the air between the cities.

If we could land a large convertible aircraft on a pier or close to a center of suburban transportation (such as the Thirtieth Street Station, Philadelphia), one could go from one's home or office in Philadelphia to the center of Chicago in four hours. This means that city-center landings and the maintenance of block-to-block time, with shorter stops, make airlines practical for trips of as little as 100 miles between main metropolitan districts.

When this is an accomplished fact, the main airlines and the feeder lines will carry at least 150 million people per year instead of the present 25 million. The dollar volume of airline traffic should at least quadruple, so that airline companies have a real stake in the quick and successful development of transport convertible aircraft of 25 to 50 passenger size (Fig. 1). This may be a better opportunity than jet travel, and both should be developed rapidly.

The Army has given little consideration to the requirements and the effects of the development of medium-sized convertible aircraft for combat service. The effects could easily be such an improvement in the tactical air force and the airborne army

that 10 divisions airborne by convertiplane would be equal to 25 conventional infantry divisions.

If we are smart enough to develop rapidly some effective combat convertible aircraft, we shall be independent of all concrete runways and be able to fly to and from unprepared ground just as far and as fast as though enemy action against our air bases had not occurred.

(Paper "The Convertible Aircraft Art" was presented at SAE Golden Anniversary Annual Meeting, Detroit, Jan. 11, 1955. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

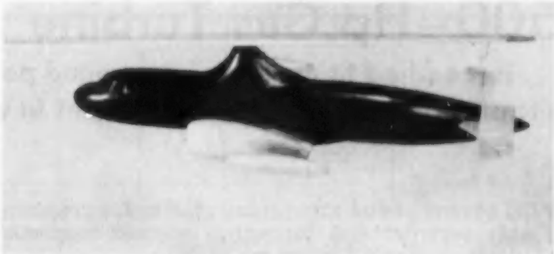


Fig. 1—A 40-passenger transport convertiplane of the future. This is what the airlines need to cut the travel time between main metropolitan districts.

Vapor Lock . . .

. . . is serious problem with only a few cars and best solved by improving fuel system design. Road tests reveal air conditioning adding to difficulty.

Based on paper by **D. P. Heath and R. H. Thena,** Socony-Vacuum Oil Co. and **Gilbert Way,** Ethyl Corp.

CRC vapor lock tests conducted on 17 makes, representing by distribution 98.3% of the 1948-1952 new car registrations, reveal the CRC procedure to be more severe than conditions encountered by all but a few cars. The tests reveal, further, that a few makes and models are more prone to vapor lock than the average.

From the data in Fig. 1, one would expect 62% of cars to suffer vapor lock at 100 F on an average 9.0 lb Reid vapor pressure gasoline, and 31% on an average 8.0 lb Rvp gasoline. But no such difficulties were met in actual summer operation. Surveys in New Jersey and California show that with fuels of 8.0 to 9.0 lb Rvp, less than 0.5% of cars in normal terrain and less than 1% in mountainous country encounter vapor lock at 100 F. The explanation is that only a small percentage of cars encounter driving conditions as severe as those used in the CRC procedure.

A few cars are much more prone to vapor lock than the average. Fig. 1 shows that at 100 F, 4% of the cars encountered incipient vapor lock on fuels of 6 lb Rvp or less. Recognizing the severity of CRC procedure, this 4% would be expected to meet difficulty with normal fuels of 8 to 9 Rvp, and owners reported that they did.

These cars pose a problem to the refiner. If he produces fuels to satisfy all of them under all conditions, he will deprive the majority of his customers of the benefits of volatile gasolines. The refiner has and will continue to produce fuels which provide the best all-round performance for a very large majority, and the prevention of occasional vapor lock in the most severe cars will have to come from improved designs.

A relatively new development having significant effect on the vapor lock tolerance of cars is the use of air conditioning. In the car tested the heat removed from within the body is dumped under the hood and the marked increase in fuel system temperatures reduced the Rvp tolerance from 8.1 to 5.5 lb.

This presents a dilemma to the customer who invests $600 to $800 in air conditioning to keep his car cool in hot weather only to have his car operate poorly in hot weather. It is a problem to be solved by the automotive industry. (Paper "Passenger Car Vapor Lock" was presented at SAE Golden Anniversary Annual Meeting, Detroit, Jan. 11, 1955. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

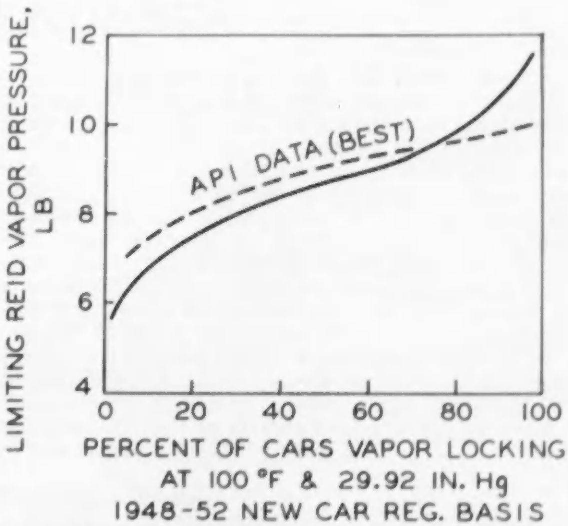


Fig. 1—Showing the limiting Reid vapor pressure for 17 makes of cars tested under CRC vapor lock test procedure. It reveals how few cars relatively are much more prone to vapor lock than the average

500–Hp Gas Turbine . . .

. . . is modified to make mobile ground power unit for support of gas turbine propelled aircraft or missiles. Is relatively light in weight and small in size.

Based on paper by **P. G. Carlson,** Solar Aircraft Co.

THE advent of the air turbine starter for cranking large turbojet and turboprop engines suggested adaptation of the Jupiter gas turbine to furnish all or part of its output in the form of compressed air. Accordingly, the Solar Aircraft Co. undertook modifications which resulted in the opening up of a new field of application, namely, as a ground power unit for starting turbine propelled aircraft.

The Jupiter series engines, developed under Bureau of Ships sponsorship, was designed to be used in either of two forms. One is a simple, single-shaft unit with a high flywheel effect for driving such loads as a-c electric generators; the other is a 2-shaft or split-wheel unit offering torque multiplication. In the former, known as the Model T-520 (Fig. 1), the three turbine stages are bolted together and the power output is taken from the compressor end. Both have low rotative speeds, stresses, and operating gas temperatures, and the structural members are designed to carry high shock loads. The overall specific weight is approximately 1.4 lb per hp.

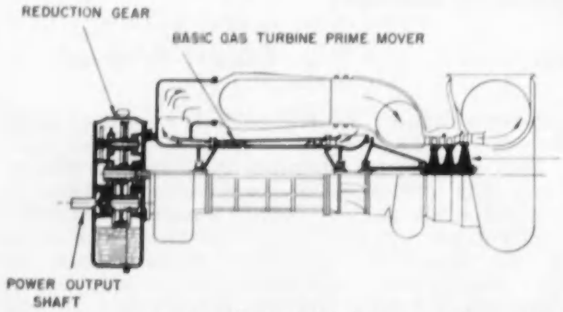


Fig. 1—Schematic view of single-shaft Solar Jupiter gas turbine modified to furnish all or part of its output in form of compressed air to extend its field of application

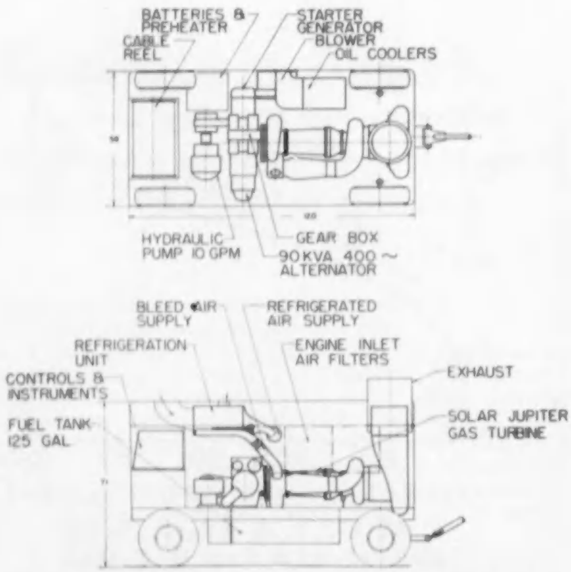


Fig. 2—Aircraft ground support unit developed from Jupiter gas turbine. Cart mounting gives mobility to perform role of cranking large turbojet and turboprop engines

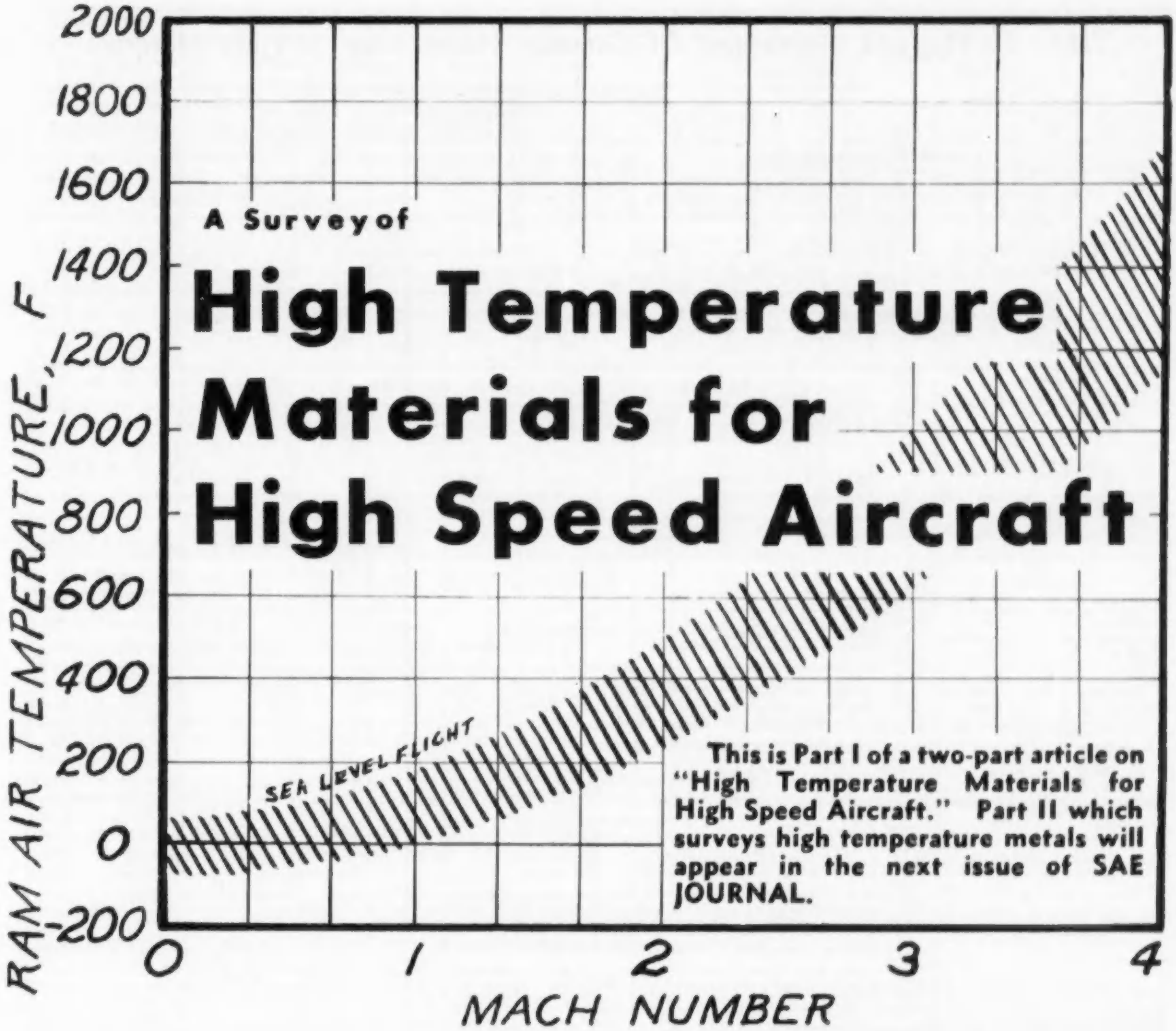
Use of compressor air bleed on the single-shaft engine was decided on in preference to driving a separate compressor from the power turbine of the 2-shaft version. The problem then became one of reducing the capacity of the turbine to accommodate the lower gas flow passing through the turbine when a substantial quantity of air is bled from the compressor discharge. The reduction of flow area could be accomplished by reducing the angle setting of the nozzle vanes and rotor blades while maintaining the existing vane and blade length, or by maintaining existing angles and reducing the length.

The double wall construction, that is, outer shell for structural support and a series of inner rings or shoes to reduce the temperature of the outer shell and minimize differential expansion between the rotor tips and the stator, made the latter adaptation far easier from the standpoint of tooling costs. It involved only making the turbine casing inner rings deeper and cutting off the tips of the rotor and nozzle assemblies.

This method had other important advantages. Little or no change would occur in turbine efficiency, thus decreasing additional development and enabling accurate prediction of performance of the air bleed engine. The shorter turbine blades would mean lower rotational stresses in the turbine, which would permit higher operating speeds with the same safety margin, or longer life at the existing rated speed.

As a mobile ground power unit the Solar Jupiter offers the following advantages: Relatively light weight and small size, reduced maintenance costs, reliable starting in cold weather, use of same fuel as the aircraft engine, and finally, the air horsepower output increases rapidly as the ambient temperature falls, thus matching the demand for engine starting power which also increases with lowering ambient temperature.

The ground power unit is enclosed in a heavy gage aluminum shrouding and is mounted on a 4-wheel cart for mobility (Fig. 2). The cart can be made self-propelled by using a 28-v d-c motor drive and suitable transmission. Dry weight of the complete cart is approximately 2500 lb and fuel consumption ranges from 30 to 60 gal per hr, depending on load and ambient conditions. (Paper "A 500-Hp Gas Turbine Engine to Supply Compressed Air" was presented at SAE National Aeronautic Meeting, Los Angeles, Oct. 7, 1954. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)



A Survey of

High Temperature Materials for High Speed Aircraft

This is Part I of a two-part article on "High Temperature Materials for High Speed Aircraft." Part II which surveys high temperature metals will appear in the next issue of SAE JOURNAL.

DURING five minutes of combat flying at Mach 2, a fighter plane will pick up about 170,000,000 Btu. That's equivalent to 45,000 furnaces blazing away in an area the size of your living room. Finding ways to protect the aircraft structure, equipment, and passengers from this immense heat is the greatest problem confronting aircraft designers today. And as flight speeds increase, heat from the powerplant, and from aerodynamic friction will increase, too. The high temperatures that are built up weaken the materials, both metallic and nonmetallic, in the plane.

Before we discuss the specific materials, processes, and designs used to withstand the heat barrier, it would be helpful to understand where the heating problem originates. It comes from aerodynamic heating and powerplant heating.

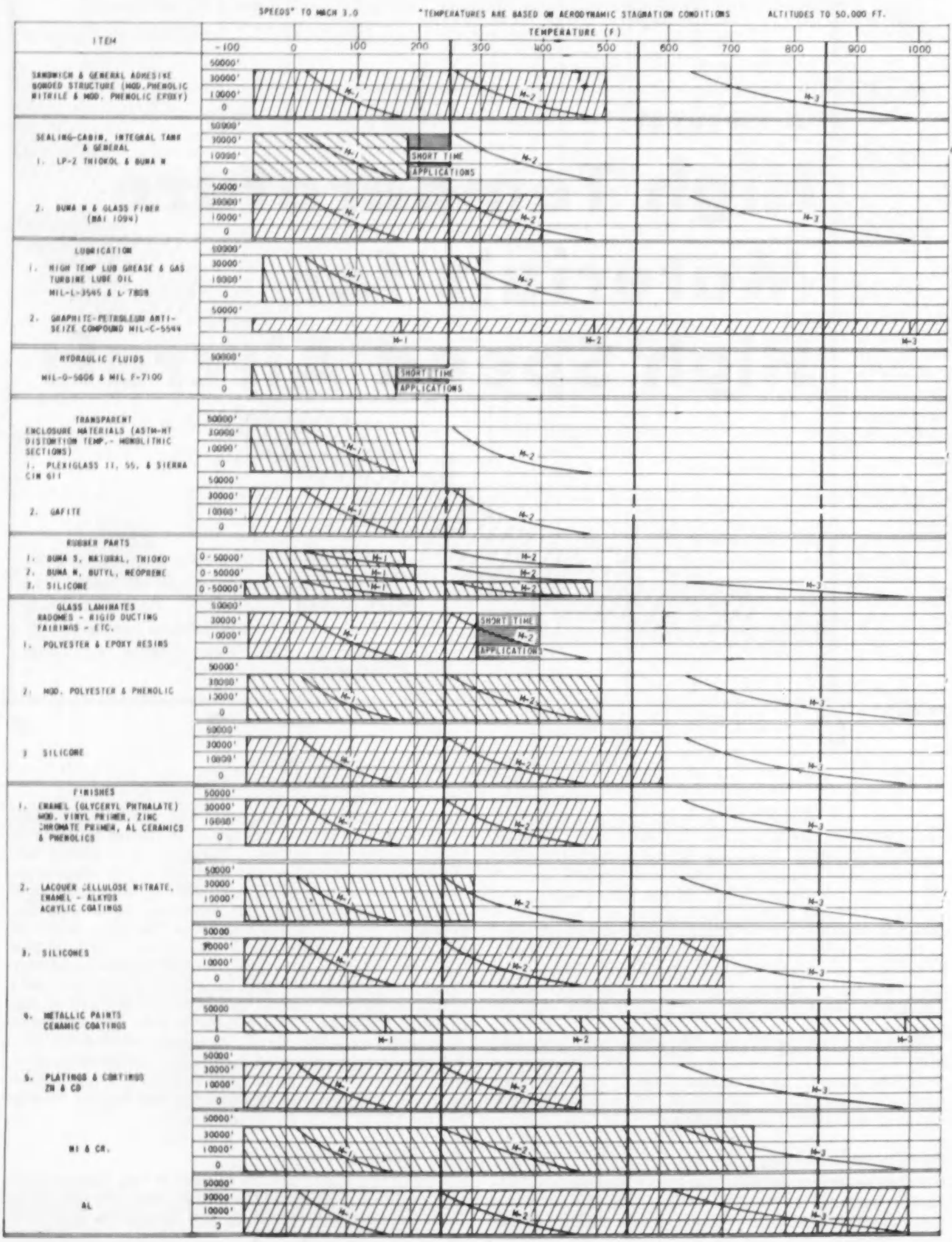
Aerodynamic heating

Aerodynamic heating, popularly known as frictional heating, is caused by the transfer of large quantities of heat from the air to the surface of the aircraft. The temperature of the air is a measure of the average kinetic energy of its molecules due to their random velocities. If the air is suddenly accelerated, as when scooped up by a jet engine or dragged along by the skin of an airplane wing, the random velocities of the molecules are also increased. So, the temperature of the thin layer of air, which is travelling at the same speed as the plane, rises. This air layer is known as the boundary layer and it varies in thickness from practically zero near the nose to several inches at the aft end of the aircraft fuselage. The aircraft's skin absorbs heat from the boundary layer. At speeds of Mach 3, flying at altitudes around 50,000 ft, the aerodynamic temperatures will rise as high as 650 F. Even higher temperatures are anticipated for the higher speeds of the future.

Powerplant heating

The other major source of heat is the powerplant. Heat coming directly from the engine surface is radiated and convected to the structure skin and

Table 1—Thermal Limitations Of Common Nonmetallic Aircraft Materials



equipment. Hot exhaust gases, too, may radiate heat to the fuselage.

In present-day engines (flying at Mach 1) the incoming air has a total temperature of about 12 F which is raised to about 560 F in passing through the compressor. Fuel is burned and the temperature of the gases entering the turbine is about 1600 F. This is about the maximum that turbines made of current materials can stand.

At Mach 2.8, the inlet total temperature would be 570 F. After passing through the compressor, air would rise to 1000 or 1100 F. That leaves only 400 to 500 deg increase in temperature left for fuel combustion with present materials. Since the only energy which is added to the air is by means of the fuel, we realize very little benefit from our turbojet engine at Mach 2.8. In fact, most of this energy would be lost overcoming the friction and component inefficiencies of the engine. So, some means must be found to advance the high temperature limits of jet engines.

What happens at high temperatures

At the high temperatures encountered in high speed flight, many materials lose static strength properties and fail to resist corrosion. Over a period of time, creep, the inelastic deformation of materials, is enhanced at high temperatures. Corrosion resistance of metals is found to decrease with time due to metallurgical changes.

Some materials react differently at room or subzero temperatures after they have been subjected to high temperatures for extended periods of time. Cyclic thermal shock and intermittent loading change creep and stress characteristics. Also, emissivity values vary with exposure time and temperature.

As you can see, aircraft design cannot be based solely on ultimate strength or yield strength in certain temperature ranges. Creep and stress rupture data govern design for high temperature use. Corrosion and oxidation resistance often are other determining factors.

Solutions to the high-temperature material problem

One might, arbitrarily, classify methods of solving the high temperature problems in one or more of the following categories.

1. **Allow the material to heat up and, possibly, deteriorate.** This may be feasible for guided missiles or where parts of the aircraft are needed for only a short portion of its total mission.

2. **Remove the heat before or as it reaches the critical material to a heat sink such as the atmosphere or a heat exchanger.** The usual method of removing heat before it reaches the structure or equipment is to pass a coolant between the source and the structure or equipment. However, transpiration cooling, sweat cooling, and film cooling are more efficient. An example of transpiration cooling is shown in Fig. 1. Equipment that is exposed to heat radiation and hot air is surrounded with a shield of porous material through which cool air is blown. Large amounts of heat can be carried off. Merely blowing cool air on the component without

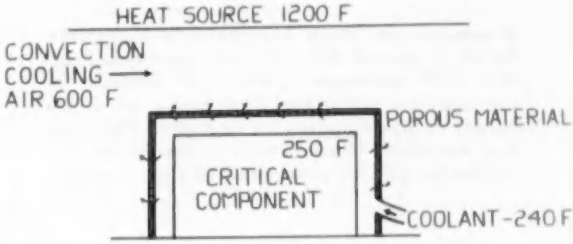


Fig. 1—Transpiration cooling is one means of dissipating heat that is built up in equipment.

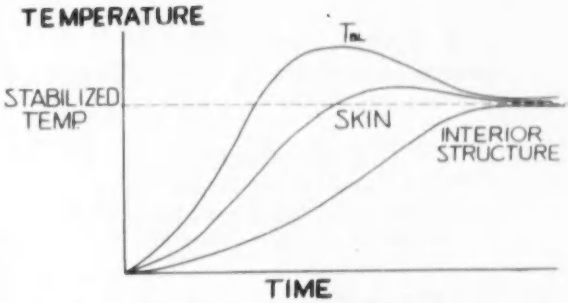


Fig. 2—Temperature rises faster on the skin surface than in the interior of the aircraft structure. Boundary layer temperature increases even more rapidly. Sometimes the high-speed, high-temperature portion of a mission can be completed before the structure material reaches too high a temperature.

the porous material would require much more air. Sweat cooling is similar to transpiration cooling except that a liquid is transpired through the porous metal.

3. **Complete the high-speed, high-temperature portion of the mission before the critical material reaches too high a temperature.** This is illustrated in Fig. 2. The upper curve describes the changes taking place in the boundary layer temperature during a portion of the mission. The skin temperature and the temperature of an interior structural point lag well behind the boundary layer temperature. The boundary layer temperature may well exceed an allowable temperature-time limit for the material if the high-temperature portion of the flight plan is completed before critical structural components become overheated.

4. **Confine the heat to those materials that can resist the effects of high temperatures.** Heat transferred between two surfaces by radiation can be reduced by using materials or coatings that have low thermal radiation emittance. This will result not only in lower structure temperatures and lesser fluid cooling requirements, but will greatly alleviate high thermal gradients existing in structural frames.

5. **Allow the material to heat up but use a better material.** The materials that are considered "better" will be discussed later. In general, materials

A seminar on "High Temperature Materials for High Speed Aircraft" was presented by the SAE Southern California Section in cooperation with the University of California at Los Angeles on Dec. 6-8, 1954, in Los Angeles. This article is based on the following papers presented at the seminar:

M. R. Kinsler, North American Aviation, Inc.
"The Aerodynamic and Power Plant Heating Problem in High Speed Aircraft"

C. S. Davis, Northrop Aircraft, Inc.
"Thermal Limitation of Common Aircraft Materials"

C. W. Alesch,
Convair Division, General Dynamics Corp.
"Some Trends in Elevated Temperature Resistant Aircraft Materials"

S. G. Demirjian, General Electric Co.
"Technological Advancements in Jet Engine Materials"

T. L. Burton, Douglas Aircraft Co.
"Hot Sandwiches-Honeycomb and Sandwich Structure"

B. L. Manire, Northrop Aircraft, Inc.
"Transparent Enclosure Materials"

F. E. Clark, North American Aviation, Inc.
"High Temperature Problems Associated With The Use of Rubber Parts in Aircraft"

L. O. Curtis, Douglas Aircraft Co.
"Open Flame Testing of Various Fiberglass Laminated Air Ducts at 2000 F"

M. Tiktinsky, Lockheed Aircraft Corp.
"The Selection of Metals for Airframe Components as Affected by Operating at Elevated Temperatures Up to 600 F"

J. W. Huffman, North American Aviation, Inc.
"Application of Metallic Materials for Aircraft Structures in the Temperature Range 600-1100 F"

A. V. Levy, Marquardt Aircraft Co.
"Application of Metals for Power Plants in the Temperature Range 1100-2400 F"

J. V. Long, Solar Aircraft Co.
"Ceramic and Metal Protective Coatings for High Temperature Materials"

A Special Publication, SP-128, compiled of the above 12 papers, is available from the SAE Special Publications Department, 29 West 39th Street, New York 18, N. Y. Price: $3.50 to members; $7.00 to nonmembers.

with low thermal conductivity and high specific heat and density will heat up more slowly than the boundary layer. The term thermal diffusivity (the thermal conductivity divided by the specific heat and the density) is used to describe these thermal properties of a material.

Of all the methods suggested, the last is probably the one on which materials and processes engineers are spending the most effort. Progress is being made in both the metallic and nonmetallic materials fields. New materials are being developed, and old materials are being reinvestigated to make the most of their inherent properties. Here's what's happening in the nonmetallic materials field:

Part I—Nonmetallic materials

Common nonmetallic materials currently used in high-speed aircraft include glass, plastics, rubber, oil, paints, and ceramics. As shown in Table I, there is a great need for new and better materials for use at speeds above Mach 2. Let's see how high temperatures affect materials now in use and the possibilities for improving their properties for use at higher speeds.

High temperature destroys rubber

At high temperatures rubber oxidizes. Physically, there is a reduction in chain length (chain scisson) and an increase in cross linking. Chain scission leads to a softening of the polymer, while increased cross linking causes hardening and a loss of flexibility. Both effects occur simultaneously, although not necessarily at the same rate. Either chain scission or cross linking, if carried far enough, results in loss of all useful properties. Chain scission predominates with natural rubber compounds, while cross linking predominates with most synthetic rubber compounds.

Even in the complete absence of air, rubber will deteriorate at high temperatures because the heat ruptures the chain bonds. There are antioxidants

that will inhibit the oxidation of rubber for relatively long periods, but none has been found effective above 300 F. Immersing the rubber in oil, will protect it from oxygen; but the oil may attack and swell the rubber, or plasticize it.

Any strain on the rubber molecules, whether from tension, compression, or shear, makes the rubber more subject to chemical attack. Rapid flexing is much more deleterious than static loading because it causes heat buildup, and rubber cannot dissipate the heat easily.

So, there is a need for a new kind of rubber or flexible plastic that can withstand high temperatures.

New high-temperature rubbers

Several new materials have appeared recently, although we are still a long way from solving all our problems. New silicone rubbers, polyacrylate rubber, poly FBA rubber, Kel-F Elastomer, Teflon, and Kel-F plastics look the most promising. Fig. 3 shows the effect of aging in air on tensile strength and elongation of several types of rubbers.

New Silicones—Only silicone rubbers, of the presently available commercial rubbers, can be classed as high-temperature rubbers. One type, X-96, has excellent compression set characteristics at 350 F (15% after 22 hr). It can be vulcanized in thick sections wthout porosity with di-tertiary-butyl peroxide. Two companies are producing silicone rubbers which can be vulcanized with sulfur instead of benzoyl peroxide. These silicones can be mixed with organic rubber, such as Buna N, which will extend the useful temperature range of Buna N with some sacrifice in physical properties and oil resistance. A high tensile silicone rubber, COHRlastic HT, is now on the market. By reinforcing it with a finely divided silica, a tensile strength of 1000–2000 psi is obtained. Tear strength is increased proportionately. However, the upper temperature limit is 350 F and compression set is 25% at 212 F.

Polyacrylate—Polyacrylate rubber (Hycar 4021) has been known for several years but has not been used extensively until very recently. It is basically a polymer of ethyl acrylate and it is usually vulcanized with an amine (tri-ethylene tetramine). It is resistant to hot oils of low aniline point and dry air to 350 F. Resistance to flex cracking, oxidation, ozone, and sunlight is good. Compression set, cold flow, water resistance, and resistance to high aniline point oils are poor. The brittle point of polyacrylate rubber is about 0 F.

Poly FBA—This rubber is quite similar to polyacrylate rubber except that most of the hydrogen atoms have been replaced by fluorine atoms. It is much more oil resistant than polyacrylate rubber but the useful temperature range is the same. It is resistant to di-2-ethyl hexyl sebacate type lubricating oils; but physical properties are low.

Kel-F Elastomer—This is the most promising rubber for high temperature use which has been developed to date. It is a saturated copolymer of chlorotrifluoroethylene containing more than 50% fluorine.

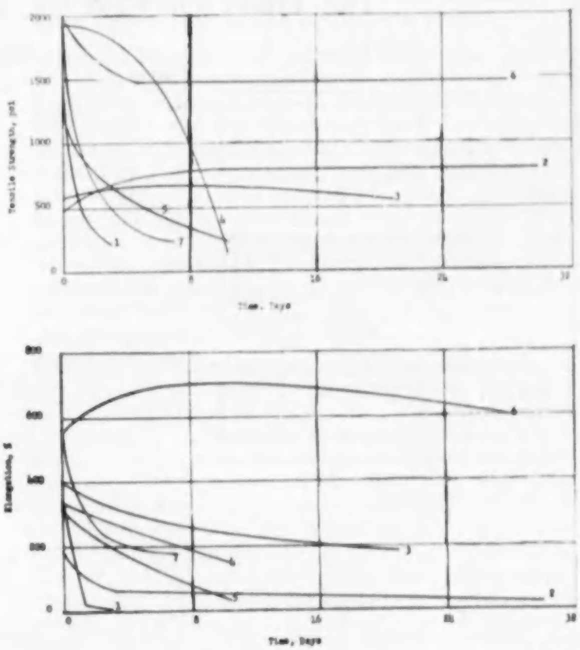


Fig. 3—The effect of air-aging on tensile strength and elongation varies considerably with the type of high-temperature rubber. In the above graphs the types are: (1) Buna N, 350 F, (2) DC-160, 480 F, (3) DC-50, 400 F, (4) Hycar 4021, 350 F, (5) Poly FBA, 350 F, (6) Kel-F Elastomer, 400 F, (7) Kel-F Elastomer, 480 F.

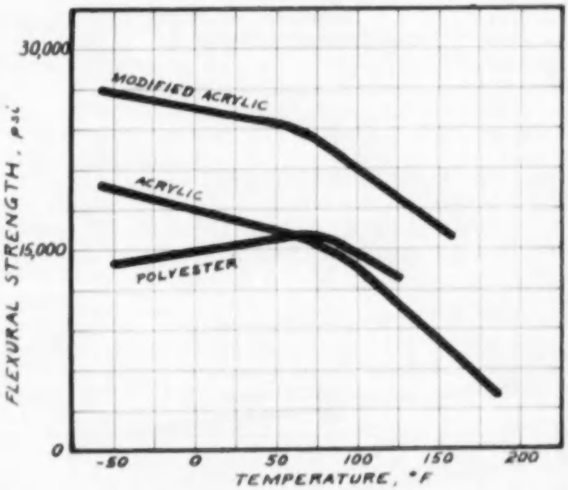
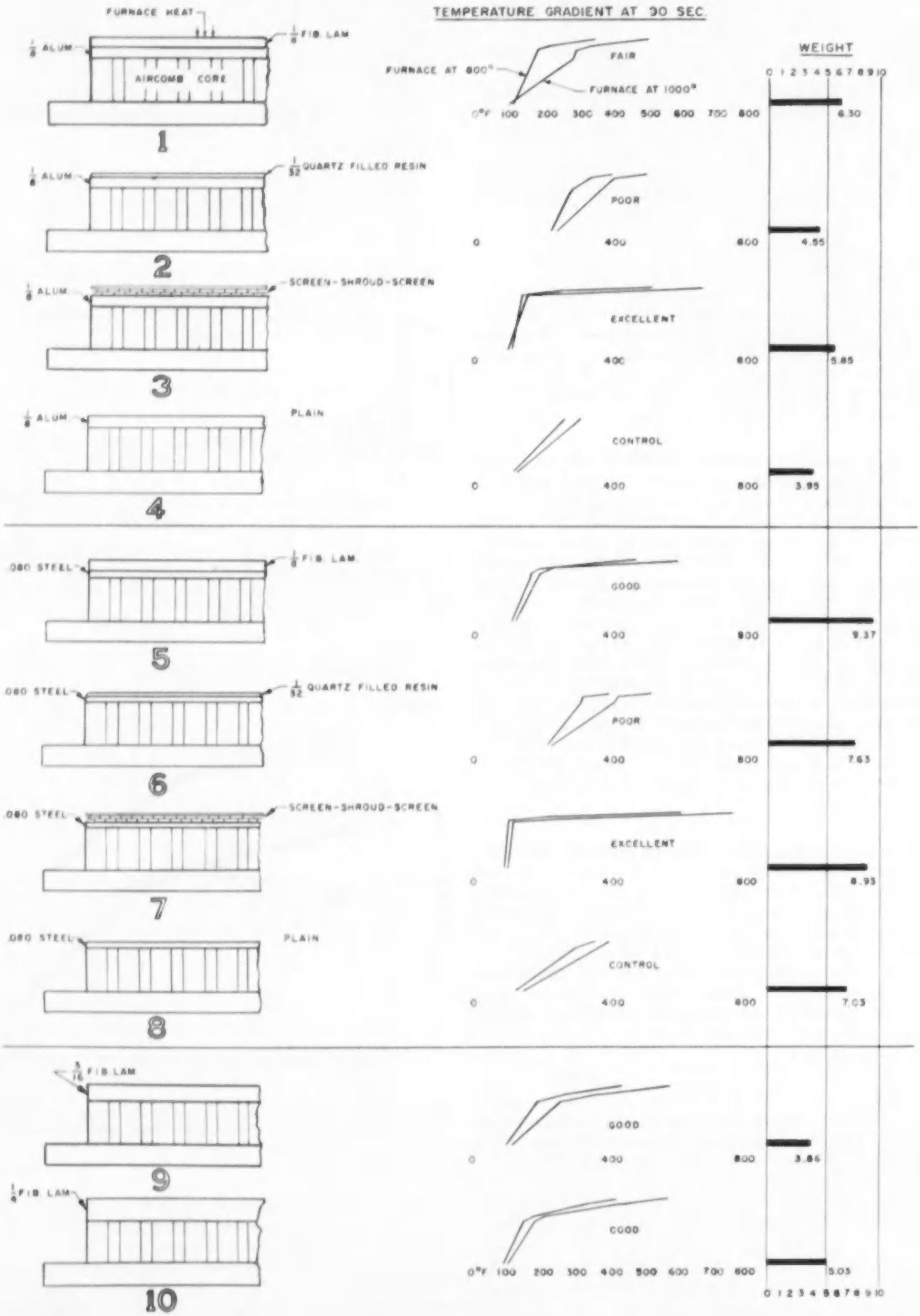


Fig. 4—Flexural strength decreases rapidly for acrylic, modified acrylic, and polyester materials above room temperatures.

It has excellent physical properties with the exception of compression set. It resists heat, solvents, chemicals, ozone, and weather. It resists white fuming nitric acid for weeks. It is soluble in ketones, esters, and cyclic ethers, and for this reason it can't be used with synthetic diester lubricating oils. Brittle point is – 60 F, but it becomes very stiff below

The Effect Of Heat on Various Sandwich Structures



20 F. It should be in quantity production during 1955.

Teflon and Kel F—Teflon is a polymer of tetrafluoroethylene and Kel-F is a polymer of monochlorotrifluoroethylene. They are not rubbers in the sense that they can be vulcanized. However, in thin sections they possess considerable flexibility and for this reason they show great promise as high temperature hose liners. They are completely resistant to nearly all chemicals, oils, and solvents. Teflon is thermally stable from below – 100 F to 550 F. Hose made of teflon is somewhat stiffer on installation than rubber hose, but it doesn't stiffen with aging as rubber hose does.

There is still much work to be done in developing adequate high-temperature rubber. The aircraft of today requires an oil resistant rubber with high physical properties over the entire temperature range from – 65 F to 400 F. Tomorrow's plane will need rubber which can withstand 600 F temperatures.

Transparent enclosure materials

Presently available transparent materials for aircraft enclosures may be classified in four main groups according to their chemical makeup: (1) acrylics, (2) polyesters, (3) modified acrylics, and (4) glass.

1. **Acrylics**—Standard materials for many years, the acrylics are characterized by good formability, stability to outdoor weathering, and excellent optical properties. They are susceptible to solvent attack, are easily scratched, and have comparatively low resistance to elevated temperatures.

2. **Polyesters**—The material is characterized by excellent graze resistance, good abrasion resistance, and optical stability. The polyesters are difficult to form and have a comparatively low heat distortion point.

3. **Modified Acrylics**—Just coming into production for aircraft use, these materials have many of the attributes of the regular acrylics but have better resistance to craze and improved elevated temperature resistance. They will probably be used on aircraft in the immediate future.

4. **Glass**—The oldest of glazing materials, has in the past been used in aircraft primarily in specialty applications such as bullet resistant windshields and camera windows. Glass has recently begun to supplant plastic in the remainder of the transparent enclosures and it is expected that this trend will continue as flight speeds increase. Glass has many advantages such as high temperature resistance (especially if tempered), and abrasion resistance. Among the obvious disadvantages are its weight, difficulties in attaching, poor formability, shatter characteristics, and low resistance to thermal shock.

Another material is laminated transparencies of both plastic and glass. Laminated glass has been used in automobiles as safety glass for many years, while laminated plastic has been used for only a few years as a pressurized cockpit enclosure. The plastic interlayer, which is generally plasticized polyvinyl butyral imposes a temperature limitation of 165 F on the laminate. The Air Force is trying to develop a material that can withstand higher temperatures.

The organic plastics, as a class, are poor conductors of heat. This is a mixed blessing in that while the mass of the plastic will not be thoroughly heated during short-time high-speed flight, neither will the plastic conduct heat away during high-speed sustained flight. Because of this thermal gradient through the plastic we can make use of the portion which has retained its strength.

The effects of temperature on plastic properties are shown in Figs. 4, 5, and 6 for acrylic, modified acrylic, and polyester materials.

In general the weather resistance of the transparent plastics is excellent. There is a slight tendency for the older materials to become brittle and the interlayer in laminated sheets to deteriorate.

Stresses in the material may cause craze—a fracture in the surface of the material.

There has been some improvement in transparent plastic enclosure material during the past few years. For example, with very little degradation in optical properties, the heat resistance has been in-

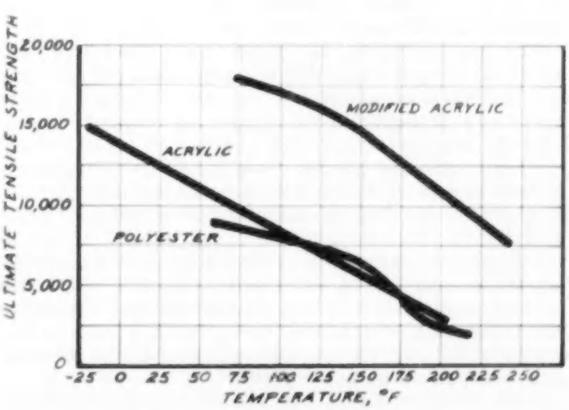


Fig. 5—Tensile strength of modified acrylic materials is greater than that of polyester at comparable temperatures.

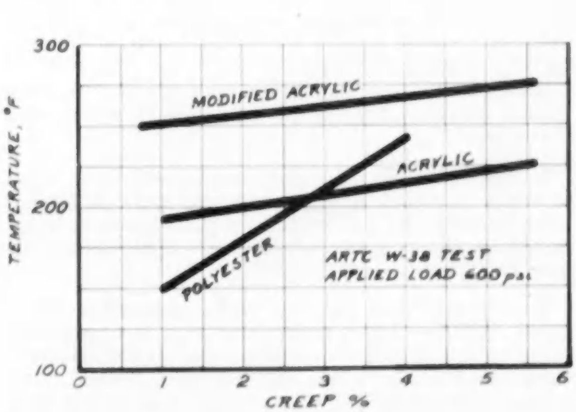


Fig. 6—Tensile creep of polyester material increases much more slowly than acrylic as temperatures are increased.

creased from 160 F to 275 F. It is reasonable to expect continued progress.

Reinforced plastic materials

The ever increasing use of reinforced plastics for high-temperature applications is indicated by the fact that in 1948 there were approximately 15 different phenolic laminated parts on a typical aircraft; in 1955 approximately 85 parts were being used on a jet engine bomber.

Mostly this material is used for air ducts of complex shape and compound curvature. They are used in the powerplant and auxiliary powerplant sections, and in air conditioning and thermal deicing systems for ducting air at temperatures between − 65 F and 500 F.

Besides saving weight, the reinforced plastic materials require tooling costs much lower than the costs of welded metal ducts made by conventional drop hammer methods and expensive metal dies.

The technique most commonly used by the aircraft industry to manufacture laminated plastic parts is the low pressure vacuum bag process. Inexpensive male, hollow, breakaway plaster molds are reproduced from a master mold. After oven curing the plaster mold and coating the surfaces with a release agent, tailored strips of glass fiber cloth, preimpregnated with plastic resin, are layed around the mold to the required lamination thickness. By this method the thickness and stiffness in local areas can be varied as desired. Bleeder strips, to absorb excess resin, and a thin cellophane (polyvinyl alcohol or polyvinyl chloride) bag are next applied and the bag sealed. The entire assembly is then placed in a temperature-controlled oven and the air evacuated from the bag, which creates a pressure of 12 to 14 psi on the part.

Temperature and time required for curing varies with the type of plastic resin and the thickness of the laminate. After the oven cure, the vacuum bag is removed, the plaster mold is broken away, the part is given a post-cure, it is inspected and cleaned, holes are drilled, and attaching parts are added as required.

Because of the ease of manufacture, and the difficulty of forming complex shapes from stainless steel, glass fiber laminate has great potential for replacing stainless steel for aircraft ducts.

The CAA and the Air Force require that air ducts in fire hazard areas must withstand a direct flame impingement of 2000 F for a minimum of 15 min without burning through.

Recent tests were conducted to determine if glass fiber laminates meet these requirements. It was found that:

1. Silicone resin glass fiber laminated ducts, with or without nickel coating, can withstand a 2000-F open flame for 15 min without a burn-through when tested in either static air or with a minimum air flow of 100 fps.

2. Polyester and phenolic resin glass fiber laminates, of the high-temperature and fire-resistant types tested, will sustain combustion and emit acrid fumes and smoke when exposed to a 2000-F open flame. This should preclude their use in fire zone areas as interconnecting ducts for cabin air-conditioning systems.

3. Electro deposited nickel coatings of 0.002-in. minimum thickness applied to rigid-type laminates provide a considerable degree of surface protection against flame erosion and subsequent penetration.

4. The rate of flame erosion is somewhat proportional to the laminate thickness. This is particularly evident wth silcone glass fiber materials.

5. The cooling effects of ram or induced air when directed through a laminated glass fiber duct at a minimum flow rate of 100 fps, in addition to dissipating any combustible gases present, substantially increases the resistance of the part to flame progression.

Other high-temperature tests are being made on both silicone and other types of reinforced plastic materials, to investigate the use of glass fiber laminates on high-speed aircraft.

Hot sandwich structures

One means of combating the high temperatures built up during high-speed flight is using sandwich structure. During the last eight years at Douglas Aircraft Corp. a phenolic resin-impregnated paper honeycomb sandwich structure known as *Aircomb* has found many uses. Tests have proved that it can withstand oven heating of 800 F for 90 sec. This corresponds to aerodynamic heating of lesser degree. This type of non-metallic honeycomb structure is good for light-weight, panel-type structure where heating occurs for short periods of time. At present it is being used in missile fins.

A series of laboratory tests on 10 panels of various face materials and insulating layers were made. Steel, aluminum, and plastic laminated faces were used; insulation was either plastic or metal. The results are shown on page 36.

Present *Aircomb* structure can stand sustained temperatures of approximately 200 F. Present adhesives decrease in strength over 200 F. High temperature properties could be improved but only at the expense of the normal temperature properties, or the life expectancy.

Aluminum skin panels seem to run slightly hotter than steel skin panels due to their lower heat capacity. A shiny aluminum surface should offer insulation to heat radiation and reverse the steel-aluminum difference.

The most effective insulators are those with the greatest temperature drop across them. Poor insulation may be worse than none if it has a rough surface which gives a much greater convective and radiant transfer.

Aluminum skin panels, with insulation consisting of two layers of sheet metal separated by screens, give good temperature characteristics but are heavy and difficult to construct.

Plastic skin panels consisting of 3/16-in. glass fiber laminate, and 1/4-in. glass fiber laminate show the best characteristics of the panels tested. Although the temperature gradient is not as good as in the screen-insulated panels, the construction is simpler and the plastic panels lighter.

Further information about hot sandwich structures can be found in the April 1955 issue of SAE JOURNAL, p. 52.

A Key to the Vapor Lock Problem . . .

. . is in the fuel pump. One way to increase the vapor handling capacity of a fuel system is to increase the size of the valves in the fuel pump cover.

Based on paper by **J. D. Caplan and R. E. Wilson,** Research Laboratories Division, General Motors Corp.

USING a fuel pump cover with larger valves will decrease the pressure drop across the outlet valve. This will allow using a fuel with a greater Reid vapor pressure before incurring borderline vapor lock.

Fig. 1 is a schematic drawing of a typical diaphragm fuel pump. The eccentric on the camshaft, through its action on the rocker arm, pulls the diaphragm down and compresses the coil spring. This sucks fuel in through the inlet valves. Then the spring expands, moving the diaphragm upward and compressing the fuel. (The maximum discharge pressure is limited by the force the coil spring can exert at the beginning of the recovery stroke.)

As the diaphragm continues upward, forcing the fuel out the valve, the spring expands and the spring force decreases. The diaphragm stops its stroke when the pressure of the fuel in the pump cavity equals the force of the spring. Thus, the length of the discharge stroke and the amount of fuel delivered depends upon the pressure of the fuel above the diaphragm.

Now, if a high volatility fuel is used, the diaphragm must increase its recovery-compression stroke. Without vapor present, the fuel would be essentially incompressible, and the diaphragm would have to recover only a very short distance to reach the discharge pressure. As the amount of vapor increases, the fuel becomes more compressible. Thus the diaphragm has to move a greater distance before full discharge pressure is exerted.

Also, the length of the suction stroke is increased to make up for the vapor in the fuel, and supply the engine with enough fuel.

This means that less time is available to discharge the increased volume of fuel. Consequently the velocity through the outlet valve is increased and outlet pressure decreased.

Theoretically the discharge pressure should be equal to the compressed spring pressure. If it is calculated for the length of diaphragm stroke which occurs during vapor lock, it is found to be much higher than the actual outlet pressure. This difference (the pressure drop across the outlet valve) is part of the reason for the relatively high pressure above the diaphragm at time of lock which shortens the pump stroke.

Also, there is a pressure drop between the pump outlet and the carburetor float bowl which prevents the pump from taking a full stroke.

One way of increasing the outlet pressure, (and thereby decreasing the pressure drop) is by increasing the size of the valves. This will decrease the pressure above the diaphragm, allow a longer stroke, and increase the total mechanical capacity of the pump.

Thus it is possible to handle fuels with greater vapor content before incurring vapor lock.

(Paper "Characteristics of Fuel Pump Operation During Vapor Lock" was presented at the SAE Summer Meeting, Atlantic City, June 11, 1954. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Based on Discussion

Al Cleveland, Ford Motor Co.

The pressure variation which was observed during the laboratory experiments was probably an effect of hydraulic ram waves introduced by the valving. The decrease in pressure variation at greater vapor pressure was probably an indication of the lower density and greater elasticity of the transfer media. Further research may give a more positive means of determining incipient vapor lock at the pump as well as improving fuel pump design.

T. W. Legatski, Phillips Petroleum Co.

Vapor lock is a problem which can be solved by (1) forcing the fuel through the fuel system with a booster pump, (2) enticing the fuel to flow by suction. The diaphragm fuel pump uses the latter. During the last war, the use of a multiple-valve fuel pump increased the Reid vapor pressure for incipient vapor lock or the rate of fuel delivery for the same RVP fuel. It would seem preferable, and possibly more accurate, to attribute this to "decreased vapor-forming tendency resulting from lowered pressure drop through the pump inlet valve," rather than "increased vapor-handling capacity."

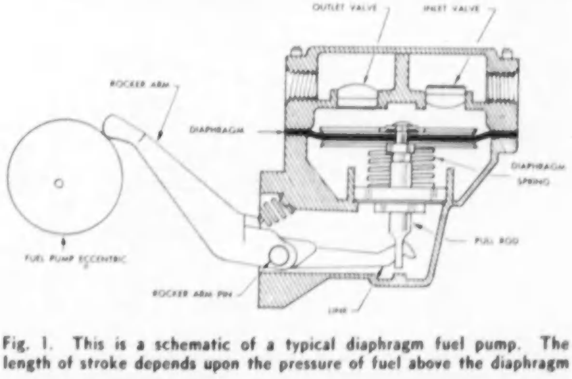


Fig. 1. This is a schematic of a typical diaphragm fuel pump. The length of stroke depends upon the pressure of fuel above the diaphragm

High Compression Engines

Attractive gains in power and economy are possible when tractor engines are designed to use high-octane fuel

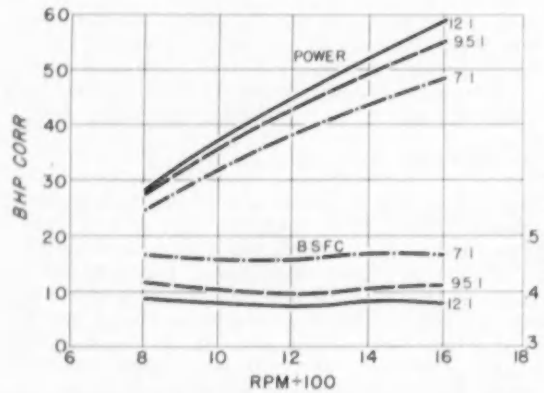


Fig. 1—Power and fuel economy at three compression ratios as related to engine speed for 800 to 1600 rpm. Engine equipped with radiator, fan generator, and air cleaner to simulate the as-installed condition.

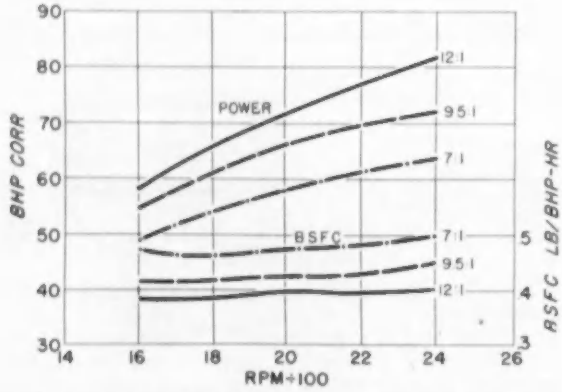


Fig. 2—Power and fuel economy at three compression ratios as related to engine speed for 1600 to 2400 rpm. Engine equipped as installed.

A TRACTOR engine, incorporating some of the basic design features heretofore found in high-performance passenger-car engines, can provide similar gains in power and fuel economy. It can make use of the higher-octane fuels, and operate at higher compression ratios and higher volumetric efficiencies. As far as ease of starting, flexibility, and smoothness are concerned, there are no operational problems.

This was indicated by tests of Oliver Corp.'s new experimental engine (XO-121) in the laboratories of the Chrysler and Ethyl Corporations.

The engine's combustion-chamber design allowed higher compression ratios and increased volumetric efficiency. It was a 4-cyl, overhead-valve engine having a bore of 3¾ in. and a stroke of 4½ in. Displacement was 198.8 cu in. The crankshaft was counterbalanced and carried in five, trimetal on copper-lead, precision shell-type bearings. Main journals were 3.00 in. in diameter and crankpins were 2.312 in. Exhaust valves were 1 11/32 in. in diameter and intake valves 1¼ in.

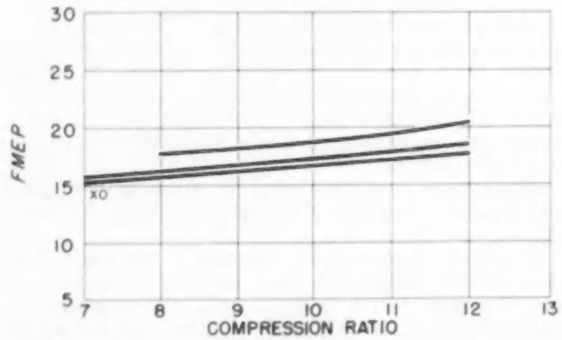


Fig. 3—Friction related to compression ratio for XO-121 engine and two V-8 passenger car engines with equal piston speeds (1200 fpm).

for Tractors Are Feasible

H. T. Mueller and R. E. Gish, Ethyl Corp.

Based on paper "Tractor Engine Design Requirements for Best Fuel Utilization" presented at SAE National Tractor Meeting, Milwaukee, Sept. 16, 1954. This paper will appear in full in the 1955 SAE Transactions.

Starting and ignition systems were 12-v. The distributor had a single breaker and was controlled only by its centrifugal advance mechanism. Champion C-88-S spark plugs were used at the 12/1 compression ratio. They were 14-mm and shielded.

Performance Better at High Compression Ratios

Brake horsepower was increased and brake specific fuel consumption was reduced as the compression ratio was increased from 7/1 to 12/1. Fig. 1 shows the results at full throttle for speeds of 800 rpm to a governed point of 1600 rpm. A 19-mm carburetor venturi was used. The average improvement in power and fuel economy of the 9.5/1 ratio over the 7/1 was 12.3%. The 12/1 ratio improved power and fuel economy 17.85%.

Fig. 2 shows that even more power gain could be realized by shifting the governed speed to a higher level. At 1800 rpm there was 11% improvement, 20% at 2000, 26% at 2200, and 31% at 2400 rpm. Only relatively minor losses in brake specific fuel consumption accompanied these power gains.

At part load the same trend in improvement was evident.

Friction Decreased by Low Stroke-Bore Ratio

The XO-121 engine's friction characteristics were compared with two high-performance V-8 passenger-car engines. Fig. 3 shows the effect of compression ratio on friction mean effective pressure at the same equivalent mean piston speed. It indicates that a lower stroke-bore ratio might improve the friction level even more. However, actual gain could be counteracted by an accompanying decrease in indicated thermal efficiency. Reducing friction also increases economy, especially at part throttle.

XO-121 Compared to V-8

Comparisons of volumetric efficiency and brake mean effective pressure were made between the XO-121 and a V-8 engine equipped with a 2-barrel carburetor. Both sets of bmep data were corrected to the same conditions: 29.92 in. of Hg and 60 F.

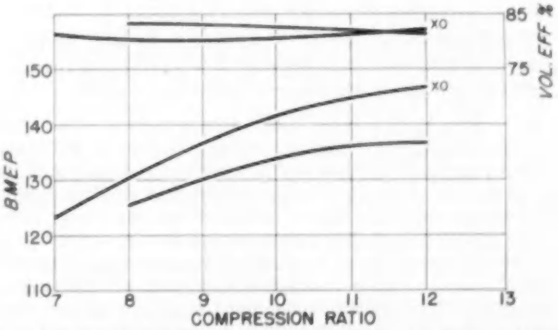


Fig. 4—Comparison of XO-121 engine and V-8 with respect to bmep and volumetric efficiency at 1600 rpm. Bmep data are corrected to 29.92 in. of Hg and 60 F. V-8 engine equipped with 2-barrel carburetor.

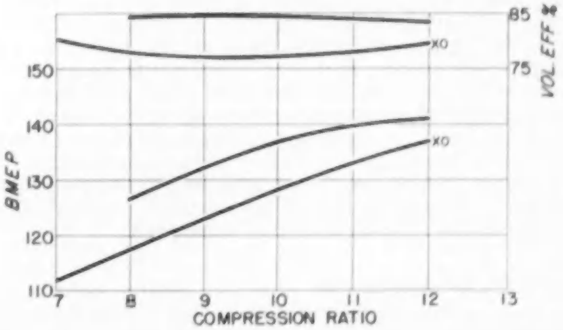


Fig. 5—Comparison of XO-121 engine and V-8 with respect to bmep and volumetric efficiency at 2400 rpm. Data were taken with ignition timing and air-fuel mixture set for best economy.

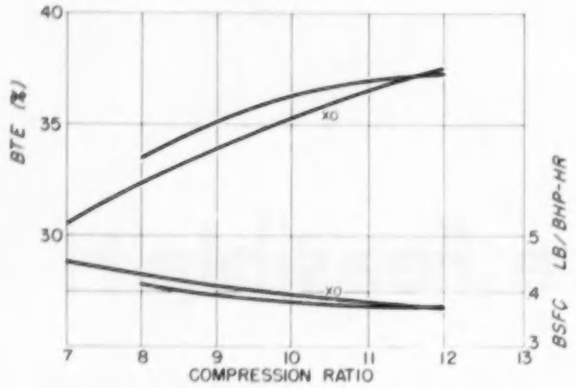


Fig. 6—Relation of brake thermal efficiency and brake fuel economy to compression ratio for the XO-121 engine and a V-8 engine.

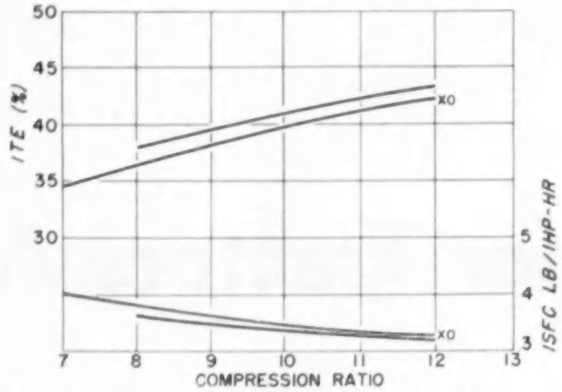


Fig. 7—Relation of indicated thermal efficiency and indicated fuel economy to compression ratio for the XO-121 engine and a V-8.

Ignition timing and air-fuel mixtures were set for best economy. Fig. 4 shows these comparisons at 1600 rpm and Fig. 5 at 2400 rpm. Note the reversal of position of these two engines with regard to bmep level at these two speeds. This is probably caused by the variations in volumetric efficiency in both engines.

Brake thermal efficiency and brake specific fuel consumption related to compression ratio are shown in Fig. 6. Indicated thermal efficiency and indicated specific fuel consumption are plotted in Fig. 7. Engine speed was 1600 rpm.

Octane-Number Requirement

The fuel antiknock requirements of the experimental engine were evaluated at the three compression ratios with both primary reference fuels and commercial gasolines. Fig. 8 shows antiknock requirements at maximum-power spark timings in the speed range from 800 to 2400 rpm. Requirement decreases substantially with speed at all three ratios. This behavior, which is quite typical, should be given consideration in the selection of the speed range for an engine. Since requirements measured at maximum-power spark timing are normally high (compared to requirements at slightly retarded settings) the power loss and requirement reduction resulting from retarding the spark are shown in Fig. 9 for the 7/1 and 9.5/1 ratios. With spark retarded to give 2% power loss, requirement is reduced about three octane numbers at both ratios. A further retardation to 5% power loss results in a total reduction of about five octane numbers. The same characteristic is displayed by the 12/1 ratio. The requirement reductions, however, cannot be directly related to those of lower compression ratios, as they are based on tel in isooctane instead of octane numbers.

It should be remembered, also, that maximum fuel quality utilization cannot be attained without designs which fully exploit fuel sensitivity.

Design Considerations

The experiments described above demonstrate that the same thermodynamic and mechanical principles presently used in passenger-car engine design can provide equally attractive improvements in a tractor engine. The following considerations should receive particular attention:

1. Compression ratio should be selected by the proper evaluation of its utilization of the antiknock quality of current fuels with due consideration of the upward trend in this quality.

2. The same general combustion-chamber design features hold true in the tractor engine as in the passenger-car engine. Some of them are compactness, short flame travel, turbulence, high volumetric efficiency (by proper valve size and minimum shrouding), uniform cooling, shape that permits full machining of all surfaces so that close control of volume can be maintained at all ratios, and good deposit scavenging.

A profile of the chamber designed for the 12/1 ratio is shown in Fig. 10. Fig. 11 shows the profile of the 7/1 chamber. Because of the relatively large volume required at this ratio, the depth of the cavity had to be greatly increased. As a result the configuration is markedly different. Although the chamber in its present form is satisfactory, certain modifications might improve its fuel utilization even further.

3. High volumetric efficiency can be obtained only when the entire induction system and its elements are in proper balance. Improved valve timing, better manifolding, and cylinder-head porting, combined with minimum air-fuel mixture charge heating, are obvious items for investigation.

4. Structural rigidity is necessary to reduce friction, and to take advantage of the antiknock quality of fuels by using higher compression ratios.

5. Lower stroke-bore ratios are a means of reducing piston friction and providing better breathing. The advantages of low stroke-bore ratio may not be as great in a tractor engine because of the lower operating speeds. Since combustion-chamber surface-to-volume ratio increases as stroke-bore ratio is lowered for a given cylinder displacement, greater heat losses to the combustion-chamber walls are incurred. Therefore, a balance must be struck between friction reduction and reduced thermal efficiency to obtain the optimum gains in performance and economy.

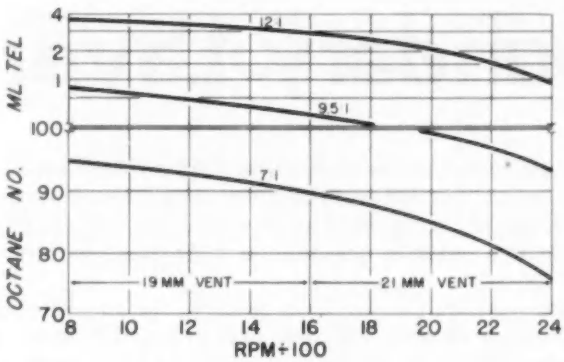


Fig. 8—Antiknock requirement for compression ratios of 7, 9.5, and 12 to 1, with ignition timing set for maximum power. Data were obtained with primary reference fuels. Air-fuel ratio set for maximum economy. Carburetor air temperature 100 F. Antiknock values exceeding 100 octane number are expressed as ml of tel in isooctane.

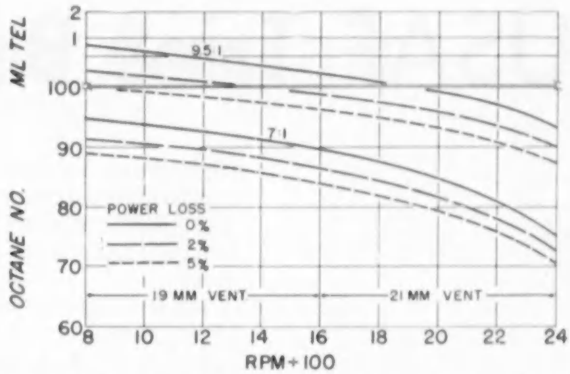


Fig. 9—Antiknock requirements of the 9.5 and 7/1 compression ratios with ignition timing set for 0%, 2%, and 5% power loss. Data were obtained with primary reference fuels. Antiknock values exceeding 100 octane number are expressed as ml of tel in isooctane.

6. In some engines one degree variation in spark advance can raise the fuel requirement by one octane number. Therefore, the distributor advance mechanism is important. Torsional vibrations transmitted to the advance mechanism from the drive can cause serious flutter or fanning of the spark timing. Obviously, such effects must be minimized to control detonation and provide stable operation.

7. Coolant temperature can have a marked effect on the knocking tendencies of an engine. Usually, local hot-spots cause the trouble rather than the high mean temperature of the coolant. Therefore, the control of coolant flow to all parts of the jacket is essential to maintain uniform temperatures.

(Paper on which this abridgment is based is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

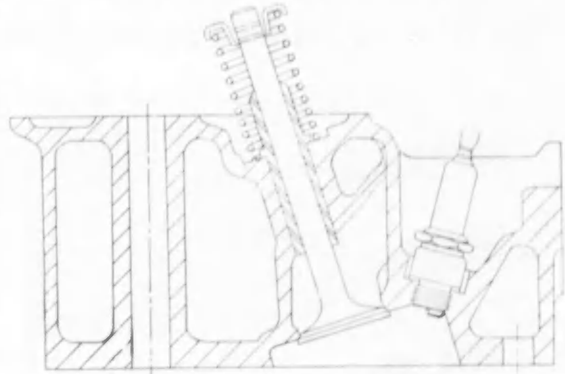


Fig. 10—Combustion-chamber profile for the 12/1 compression ratio in the XO-121 tractor engine. 9.5/1 profile is similar.

Based on discussion . . .

J. H. Eby,

International Harvester Co

In a similar high-compression-ratio investigation, we used the basic Super "H" valve-in-head engine, with some modifications in the cylinder head and induction system. Changes in compression ratio were obtained by using individual cylinder heads, all having the same basic shape combustion chamber, but having different volumes. Tests have shown from 3½ to 5% improvement in economy and horsepower at 7.5/1 ratio, and from 6 to 8½% at 8/1, when compared to the 6.6/1 ratio.

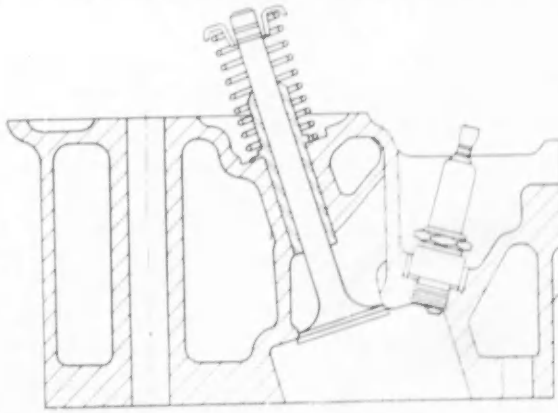


Fig. 11—Combustion-chamber profile for the 7/1 compression ratio.

The high octane requirement of the test engine at the 7/1 compression ratio is similar to the requirement we get in dynamometer tests on our new passenger-car engines. We find a discrepancy of five to seven octane numbers between dynamometer and field results. Octane requirement should be evaluated on the basis of actual operations. This suggests that we must develop new techniques for field observations for octane requirements of tractor engines.

B. G. Burnside,

Ford Motor Co.

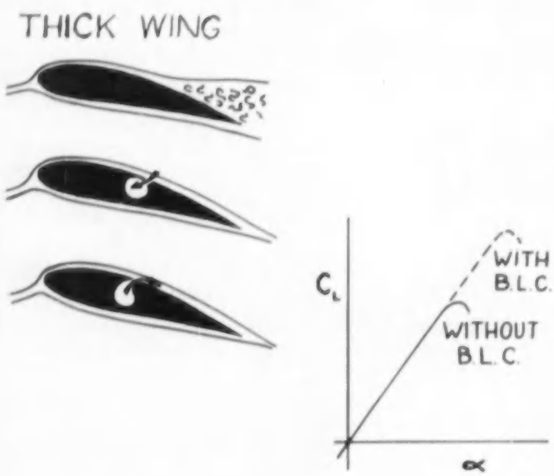
Obtaining better fuel economy based upon lower friction is the most important gain that can be realized by the engineer designer. Lower friction values can be realized by several design factors: lower stroke-to-bore ratio, improved bearing design, low expansion or low friction pistons, and good piston-ring design.

USAF Tries Boundary Layer

High speeds are fine at altitude, but the slower the take-off and landing speeds, the shorter the runway needed and the safer the pilot and plane. The trouble is, with low speeds, wing lift is slight. One way to add lift is to add wing area. But this tends to compromise high-speed performance.

A better way, experimenters are proving, is to preserve the smoothness of the airflow at the boundary of wing and airstream so that lift doesn't deteriorate. Boundary layer control can be applied to the wing itself—or as described here—to flaps and ailerons.

The Theory of BLC to Improve Flap Effectiveness

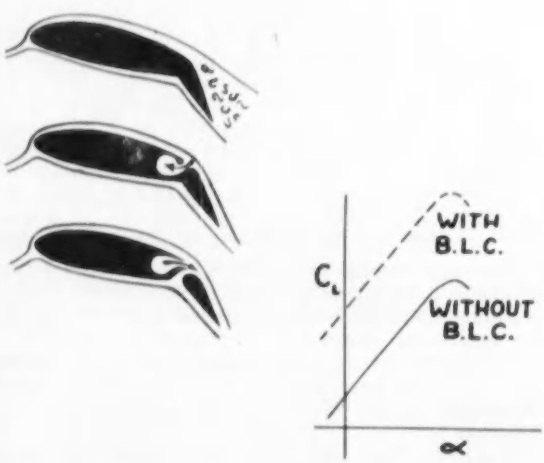


ON a moderately thick airfoil at high angles of attack, such as those occuring at landing and take-off runs, flow separation starts at the rear of the foil and progresses forward with increase in angle of incidence. If the wing has a flap, the flow is normally separated to a large extent over the rear of the flap. The flap's purpose is to increase lift, but it doesn't succeed to the extent it could if separation did not occur.

Loss of energy within the boundary layer causes the separation. It can be prevented by sucking the low-energy air in upstream of the separation point. Or it can be done by re-energizing the boundary layer by a blowing jet.

Either method increases the effectiveness of the flap in improving wing lift.

On a thin foil at high angles of attack, flow breaks away rather suddenly near the leading edge of the airfoil because of the very high pressure gradients around the nose. Separation in this case can be avoided by suction at the leading edge. This delays stall to higher angles of attack and makes it possible to take advantage of the higher lift associated with the heightened range of angles of attack.



SEPARATION cheats the airplane designer of much of the increment in coefficient of lift (C_L) with increase in flap angle that theory predicts. But boundary layer control restores it.

Thus, boundary layer control makes it possible to obtain more lift at a given flap angle, and to use higher, more effective flap angles.

Control on Two Aircraft

Joseph Flatt, Wright Air Development Center

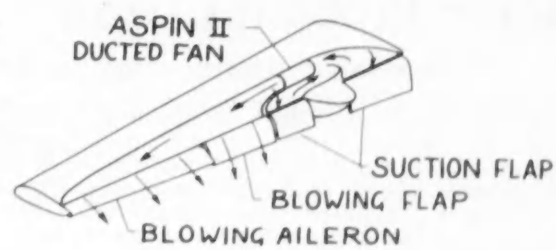
Based on paper "Some Experiments in the Application of Boundary Layer Control" presented at SAE Golden Anniversary Aeronautic Meeting, New York, April 21, 1955. Paper will be published in full in 1956 SAE Transactions.

The Application of BLC to the C-123 Cargo Plane

BOUNDARY layer control has actually been applied to the flaps of one C-123 assault-type cargo plane. Stroukoff Aircraft Corp. designed and fabricated the installation for the Air Force. The plane first flew with boundary layer control in operation on Dec. 7, 1954 at Trenton, N. J. Now it is undergoing flight evaluation at Wright Air Development Center.

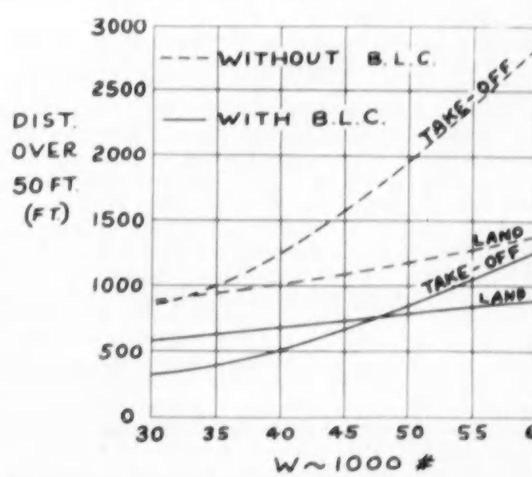
THE XC-123D boundary layer control system incorporates both suction and blowing. Inboard flaps have suction slots. Outboard flap and drooped aileron have blowing slots.

Power for pumping comes from a small ducted fan, the French Turbomeca Aspin II. It burns gasoline from the tanks for the main propulsion engines.



PRELIMINARY flight test indications are very encouraging. At a weight of 50,000 lb (which is near design gross weight) boundary layer control reduces take-off distance from 1950 to 850 ft. Landing distance at the same weight drops from 1200 to 775 ft. Minimum required field size is halved. No serious flight deficiencies have appeared.

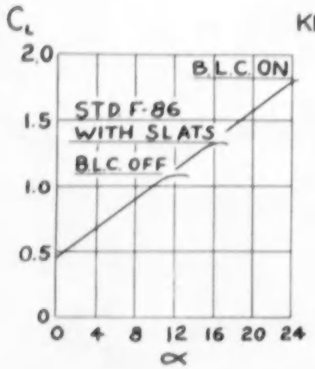
Impetus for the development came partly from study of a German proposal for a boundary layer control system for their World War II Arado 232A transport. Ejector action of a small rocket provided suction and the mixed flow exhaust the blowing. Studies Cornell Aeronautical Laboratory made for the Air Force showed this is a much more efficient way to use the fuel than is direct thrust take-off assist.

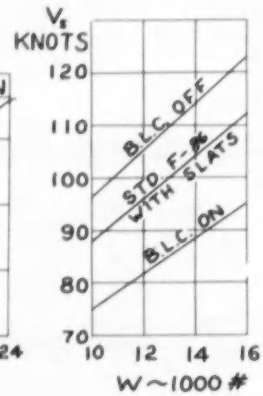


The Application of BLC to the F-86 Swept-Wing Fighter

THIS F-86 has its standard leading edge skin replaced with a porous sintered stainless steel sheet. Under the fuselage is a turbosupercharger unit modified so that its compressor sucks air ducted from a channel behind the porous leading edge. Air bled from the compressor of the fighter's propulsion turbojet powers the supercharger.

First flight with this installation was made on Sept. 18, 1953 by North American Aviation. The plane later went to the NACA's Ames Aeronautical Laboratory for development flight test.





TEST pilots quickly noticed the improvement in low-speed handling characteristics and reduction in minimum speeds due to boundary layer control. With boundary layer control off, maximum lift coefficient of 1.1 was obtained at an angle of attack of 12 deg. With boundary layer control on, a lift coefficient of 1.8 was obtained at an angle of attack of 24 deg. (The standard F-86 with full-span leading-edge slats has a lift coefficient of 1.35 at the maximum angle of attack of 17 deg.) At a gross weight of 14,000 lb, stalling speed dropped from 104 knots with slats to 88 knots with boundary layer control.

(Paper on which this abridgment is based is available in multilith form from SAE Special Publications Department at 35¢ to members, 60¢ to nonmembers.)

Brake Problems Grow . . .

. . . with increase in passenger car weights and speeds. And modern styling offers no help in the struggle to dissipate heat generated by fast stops.

Based on paper by **H. P. Hayes,** Lincoln-Mercury Division, Ford Motor Co.

IF the brake capacity of the 1947 model car is taken as standard, the brake capacity of the 1955 model should be approximately 46% greater. That's what added weight and higher speed have imposed on brake requirements.

Changes in car bodies in the interest of styling are adding to the difficulty. Modern design prescribes that brakes be tucked inside the wheels, the wheels covered by body sheet metal, and the spokes, if any, covered with decorative caps. This accentuates the problem of heat dissipation.

Racing cars, which have their brake drums almost completely exposed to a blast of high velocity air, sometimes employ air scoops to direct air onto the brake, exhausting it through holes in the brake backing-plate.

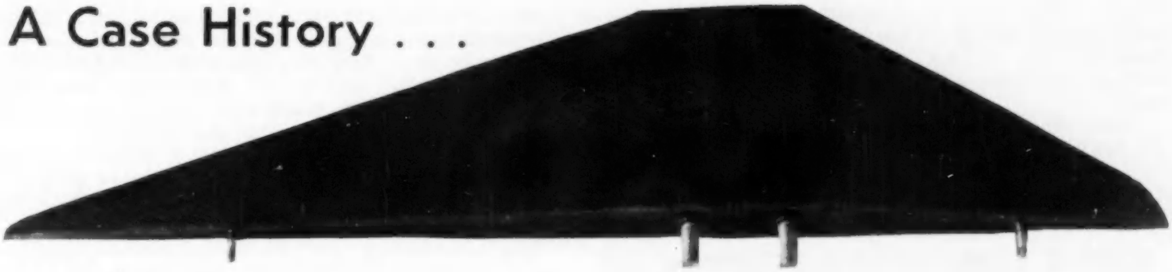
How to force or direct air to passenger car brakes is a problem. The family car cannot very well have air scoops because of the anticipated miles of travel without adjustment or repair. Mud, water, and stones that could and would be scooped up under some driving conditions would ruin the brakes. In one instance check of an air scoop revealed a rabbit wedged into it.

Thermostatically controlled, power driven blowers could be used. Vented hub caps and wheel covers that move air across the drums appear to subject the brakes to differences in temperature, right and left, when operating in side winds. This is especially true on mountain roads.

Let us assume that we find a lining, drum, or brake that is less affected by increased heat. The most vulnerable component is then the brake fluid. To prevent boiling, a super heavy duty fluid that boils around 400 F could be used. At the moment, the rubber wheel cylinder cups are the weakest part of the present brake system when temperatures over 250 F are reached. It is possible that after wheel cylinder rubber compounds are improved for temperature resistance, new high-temperature-resistant wheel bearing greases and grease seals will have to be used. It is conceivable that the tire may end up as the weakest link in the "temperature race."

(Paper "Review of Problems Existing in Present Passenger Car Brake Systems" was presented at SAE Golden Anniversary Passenger Car, Body and Materials Meeting, Detroit, March 3, 1955. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

A Case History . . .



Missile Wing in Glass and Plastic

D. M. Hatch, Jr. and Willard Crofut, Hughes Aircraft Co.

Based on paper "Development of High Quality Plastics Components," presented at SAE National Aeronautic Meeting, Los Angeles, Oct. 7, 1954.

THE fiberglass-plastic partnership has taken on a new job—wings for guided missiles.

Its physical properties make the material a natural for a missile's tough operating conditions . . . high temperatures, corrosion, fungi attack, salt spray, and electrolytic action. A method was developed that makes the phenolic-fiberglass material practical for the missile wing application and at perhaps one-tenth the cost of the part in metal.

The development program turned up five ideas on fiberglass-plastic fabrication which differ from conventional processing of the material. These new twists are what made possible a precision product. They are:

1. Proper arrangement of the glass fabric in the layup.
2. Removal of excess volatiles from the material before molding.
3. Use of precision-machined, hardened, matched tools.
4. Application of high molding pressures.
5. Establishment of precisely controlled conditions for fabricating and molding the material.

Our pattern of thinking that evolved the methods for producing these high-quality plastic parts follows.

1. FINDING THE RIGHT MATERIAL . . . Metals Lost Out

When we first considered the plastic wing, we knew it could be satisfactorily machined from magnesium or aluminum billets. (It's a small part, a bit over $7\frac{1}{2}$ in. long.) A metal wing might also be die-cast. The machined wing looked too costly because of the extensive machining needed. Another factor militating against it was the wasteful use of materials which, in time of emergency, might be classified as critical.

The choice narrowed to fiberglass and plastic. Two basic type resins commonly used with glass—polyesters and phenolics—were considered. Previous development work on a different part showed the phenolic material to be better.

The material combination has superior strength properties, especially at high temperatures. It can be fabricated by high-pressure molding techniques to produce parts of higher strength, lower porosity, and smoother surfaces than anything produced by low-pressure techniques.

Tests were made to evaluate the form in which to use the glass for best results—the fabric or macerated fabric and loose fibers. The laminated glass fabric structure proved to be the better of the two.

2. LAYUP AND INSERTS . . . A Little Design Ingenuity Turns the Trick

The problem on layup of the fiberglass material was how to get the proper distribution of material in the tapered portion of the wing. The method developed consisted of using laminations decreasing in size from the outside inward. (See illustrations.)

It was found that pieces of fabric large enough

for one complete layup could be dried, after impregnation with plastic, in stacks of 20 under light contact pressure. The dried material came from the oven in the form of loosely bonded board, 20 layers thick.

Tests on laminated parts showed that direction of fabric weave in the layup was important for proper directional strength characteristics and elimination of warping in the finished part.

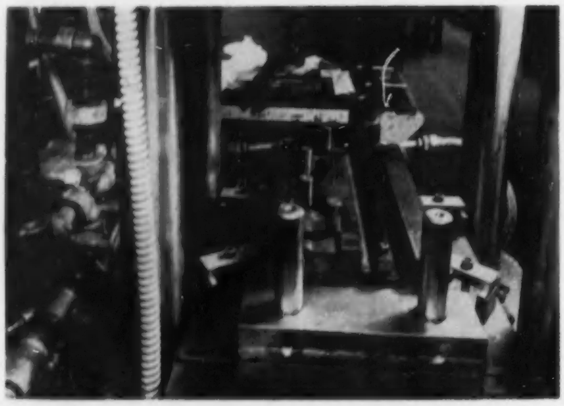
Best solution to the insert problem looked like the molding of metal attachment inserts into the wing for attachment to the main structure.

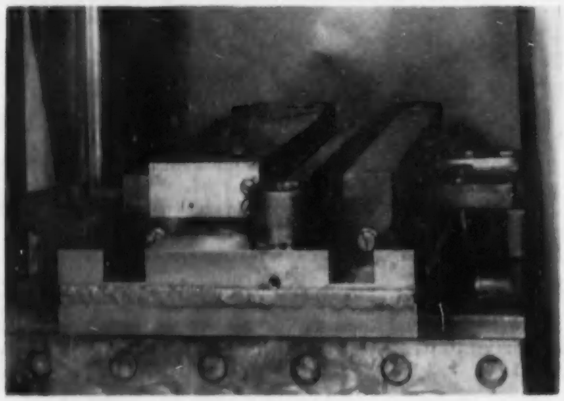
Tests to determine the pull-out strength of the material showed that those with T-shaped heads weren't adequate. Inserts with 10/32-in. of exposed thread ends pulled out at about 3400 lb. The 8/32 and 6/32-in. inserts broke in tension during the tests.

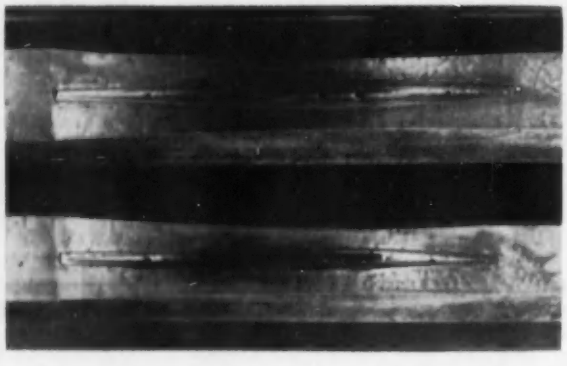
During the development, it was found that the molding process caused the inserts to bend under certain conditions. This trouble was apparent during attempts to mold a laminated skin with a macerated fabric core. The bending trouble was eliminated by changing to a U-shaped bolt, the prongs of which were the threaded studs.

When development came around to an all-laminated wing structure, the single studs proved usable without the former bending trouble. So the final

Plastic Wing Tooling

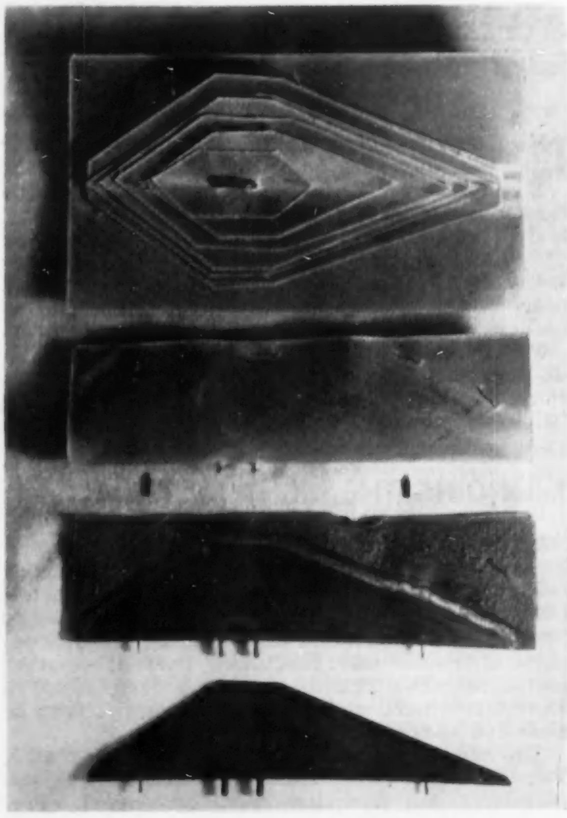






This is the final design of the mold for the glass-plastic wing. Bottom mold is shown on top, upper mold is in the middle, and removable edge section of the mold is at the bottom. This tooling was the product of considerable engineering time since it holds the key to controlled precision molding.

Processing Steps



Shown at the top are layup of the 10 phenolic-impregnated fiberglass components together with the attachment insert. Next is shown the completed layup, stapled together, and the two locating pins. Below that is the molded wing with flash attached. At the bottom is the finished part. The finished wing is a little over 7½ in. long.

design calls for two single studs with a roughly T-shaped head that's molded into the laminate with an exposed section having a 6/32-in. thread.

To locate the wing on the main structure, two very small studs—similar to the attachment studs—are molded into the part as locating dowel pins. The threads on all studs are used for holding them in position during molding. The threads are cut off after molding, leaving a plain dowel pin for positioning.

3. TOOLING DESIGN . . . Key to Success Is in the Mold

At least several tooling problems presented themselves. For one, at the time the tool had to be designed, we didn't know which form of phenolic-glass material we would use. Second, the method of trimming and finishing the part had to be considered.

We considered a positive type mold for producing the part, which would present no material cut-off problem. But this method would produce a flash line which would have to be finished. In considering designs of material cut-off lands, we could use either a shearing type or a simple compression type.

We finally selected the compression type cut-off lands. The tool was designed to make the cut-off along the wing's knife edges. It was designed as a flash type compression mold. But provisions were made for easy conversion into a transfer type tool by mounting a transfer pin at right angles to the main piston of the press. However, it was not found desirable to do this.

4. MOLDING PROCESS . . . Produces High Quality at Low Cost

We set up development of the molding process with three objectives in mind. It had to produce:

1. uniformly high quality parts
2. . . . at low cost, and
3. . . . in a way readily duplicated in standard molding facilities.

These objectives were met. And here are some of the situations that had to be taken into account.

Fiberglass fabric treated with any resin in the standard way shows variable characteristics . . . particularly ratio of glass to resin solids and percentage of volatile matter present with resin solids. Fabric treated with this phenolic resin is no exception. However, the degree of polymerization of the resin is reasonably uniform.

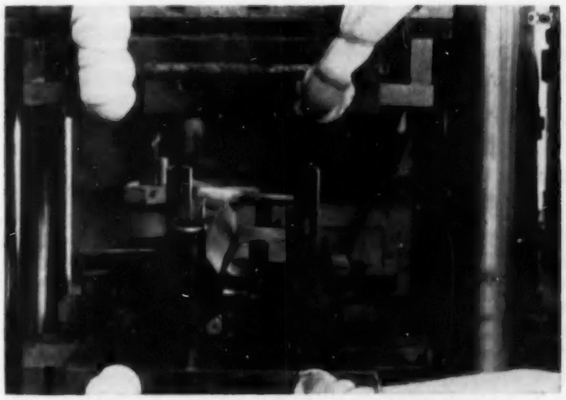
We found that we could readily produce parts with adequate structural strength on a uniform basis by doing two things: (1) careful selecting of the material with regard to resin solids content, and (2) proper oven drying of the material before molding.

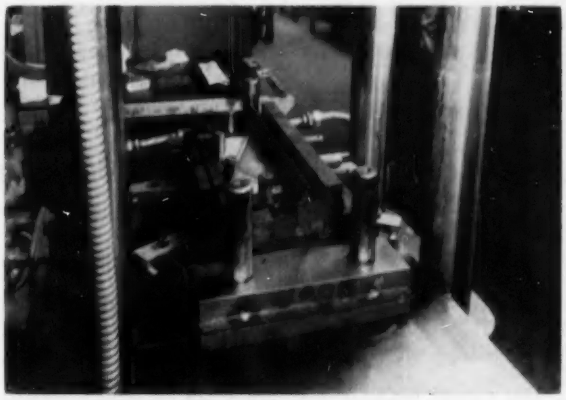
Standard molding equipment can be used. An industrial oven of sufficient capacity with proper heat supply will handle the material pretreatment as long as uniform processing is established.

Over 2000 parts were produced by our plastics laboratory. Tests showed these parts could be made uniformly of adequately high quality and at relatively low cost in quantity. Quantity estimates from outside vendors indicated a price roughly one-tenth that of machined metal parts.

(Paper on which this abridgment is based is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

The Hot Squeeze





At left is the preform as it's positioned in the mold. Before molding, the die is heated to some 320 F. First step is to close the die as quickly as possible to about a 1/16-in. separation. Die travel is stopped at this point for some 15 sec. Then the die is slowly closed for this last 1/16 in. to allow for complete heating and subsequent flow of the resin. Result is a completed molding, as shown at right.

Memo to Vehicle Designers: Don't overlook weight savings, toughness, corrosion resistance and ease of fabrication of . . . .

High-Strength

THE term "high-strength low-alloy steel" embraces a group of 15 or more different chemical compositions as made by nearly as many steel producers. Because all of those steels are proprietary, attempts to standardize on one or two chemical compositions have been largely unsuccessful. (The steels are, however, covered by the SAE Recommended Practice on High-Strength Low-Alloy Steel, SAE 950. See page 107 of the 1955 SAE Handbook.) Moreover, in some cases the chemical composition of a successful high-strength steel has arisen out of conditions surrounding the wholly owned or leased raw material sources of a single plant or company. To meet such chemical composition limits might well work a hardship on other plants. Then, too, if the chemical limits of a standard were made sufficiently wide to cover the product of the majority of producers, the consumer would have little assurance that the steel would perform consistently in fabrication and use.

But the fact that there exists a group of steels which do vary substantially, one from the other in chemical composition, yet consistently meet a standard set of mechanical property values, and which can be fabricated by standard methods, by means of standard tools, gives the consumer a latitude in selecting steel which is unprecedented.

Many of these steels are completely interchangeable with one another, or with the balance of the group. Some possess certain virtues in greater degree than others, yet all are outstanding in the field for which they were created—weight reduction.

High-strength low-alloy steels are available in any section which is available in plain carbon steel. But, of course, all sections are not produced by any one company. In addition to the standard steel mill sections which are available, there is also available a nailable floor section and all types of Yoder mill sections. It is of decided economic and technical advantage to make use of the very wide variety of rolled special shapes which the steel industry makes available.

During 1953 the automotive industry consumed 323,452 tons of high-strength low-alloy steel or about 43% of the total production in the following major categories: structural shapes, 2342 tons; plates, 18,950 tons; bars and bar-size shapes, 802 tons; sheets—hot rolled, 213,569 tons; sheets—cold rolled, 74,736 tons; strip—hot rolled, 9282 tons, and strip—cold rolled, 3771 tons. This represents an increase of 65% over 1952.

Alloy Content, Including Manganese, is Only 2-3%.

In order to secure the superior mechanical properties which high-strength steels possess, manufacturers make use of combinations of several alloying elements and deliberately reduce the quantity of carbon present in the steel in order to enhance formability and weldability. In most cases the total alloy content, including manganese, will be around 2 to 3%.

The major functions of the alloying elements are to raise the strength level of the steel, and to enhance resistance to corrosion. In these steels advantage is taken of the fact that a small amount of two or more elements is more effective in resisting corrosion than one of them in an amount equal to the combination. All high-strength low-alloy steels have been designed to be used in the as-rolled condition, a situation which is not generally true of steels which contain alloying elements. It is only in unusual circumstances that heat-treatment by the fabricator is necessary or desirable for high-strength low-alloy steels.

The most common alloying elements used in high-strength low-alloy steels in alphabetical order are: chromium, copper, manganese, molybdenum, nickel, phosphorus, silicon, titanium, vanadium, and zirconium.

Charles M. Parker,
Assistant Vice-President, American Iron and Steel Institute

Based on paper "High-Strength Low-Alloy Steels" presented at SAE Detroit Section, Oct. 25, 1954.

Low-Alloy Steels

Because of the chemical composition of the ferrite matrix of high-strength low-alloy steels and the fact that they are all of more uniform fine-grain structure than structural carbon steels, they are generally more stable and less subject to orange peel and stretcher strains than rimmed or semi-killed carbon steels. That makes them more suitable for buffing, polishing, and plating jobs such as bumpers, tail pipe covers, and robe rail supports.

No matter what combination of elements a steel manufacturer uses to produce high-strength low-alloy steel, he aims to meet the following minimum mechanical property values: tensile strength, 70,000 psi; yield point, 50,000 psi; elongation in 2 in., 22% for thicknesses ½ in. and less.

Coincidentally, other properties are enhanced as compared with plain carbon steel such as corrosion resistance, abrasion resistance, strength in shear, endurance limit, notch toughness, and strength at high and low temperatures.

Vehicles Constructed of These Steels Give Fine Service.

The yield point of high-strength low-alloy steel is about one and one-half times that of plain carbon structural steel. That additional strength permits higher unit working stresses with lighter sections for the same factor of safety. But it would be incorrect to lead you to assume that substitution can be made across the board without a change in design. The structure with the lighter section may deflect unduly under load so redesign may be necessary to take advantage of the higher strength of low-alloy steel.

The modulus of elasticity of high-strength low-alloy steels is 29,000,000 psi, a figure 2.8 times as great as that of any common nonferrous structural metal. A high value is priceless to the consumer in combatting deflection under load without permanent deformation. We have assurance, too, that the lighter steel section will withstand fatigue stresses because high-strength steels have an as-rolled endurance limit of 42,000 to 50,000 psi, some three times the endurance limit of common non-ferrous structural metals.

This latter fact is exceedingly important in truck and trailer life because few failures can be attributed to static overload. It is much more important that trucks and trailers be designed to withstand loads considerably less than maximum but which are repeated a great number of times. (The word "load" means any applied force whether deliberate lading or forces applied by road conditions, including vibration.) This characteristic of high-strength steel provides insurance against minor damage which might induce major failure such as scratches, tool marks, localized corrosion, and abrupt changes in cross section. High endurance of the steel gives more miles with fewer repairs.

Experience with high-strength low-alloy steels in truck bodies has been most interesting. For example, early in 1940 the city of Pittsburgh purchased 81 garbage truck bodies fabricated from high-strength steel. These bodies have roll tops, and the upper portion and sides can be dropped. The tail gate is provided with a rubber gasket making the body leakproof. During the summer months the body is rinsed with a hose each day, but during the winter months the trucks are not cleaned, and at times 4 or 5 in. of garbage accumulate in the body. A recent investigation revealed the trucks to be in excellent condition, while another type of garbage truck built from carbon steel and used in similar service was found to be considerably rusted. The high-strength steel truck bodies were painted on the outside only and have had to be repainted only twice since they were built.

Gasoline transport units built from high-strength low-alloy steel have proved to be sturdier and

longer lasting with more capacity than their counterparts built from carbon steel. Moreover, maintenance, operating, and repair costs have been materially reduced. In one such job, high-strength steels saved 765 lb of weight in the truck tank, and 906 lb in the trailer tank—in all, the equivalent of 257 gal of gasoline hauled on every trip for the life of the vehicle.

A type of trailer called a frameless grain trailer has been fabricated almost entirely of high-strength steels with considerable success. The purchaser reported that the weight of a 30-ft trailer was reduced by 1500 lb over the old design which employed a full carbon steel frame and wooden body. He reported that a correspondingly lighter chassis could be employed, that greater payload capacity was secured, and that specific savings were noted through reduced wear on tires, reduced engine wear, and lower license fees.

Public utility trucks, farm trucks, dump trucks, airfield repair trucks, logging trailers, mail trucks, and buses are among other vehicles enjoying lighter weight, less corrosion, more payload, and generally greater serviceability—thanks to high-strength low-alloy steels.

High-strength steels have made possible smaller and more economical engines, and in some cases smaller tires and longer tire wear, better acceleration, lighter springs, lighter brakes with added braking power and other stronger and lighter operating parts which are of vital importance. By reducing non-functional dead weight, carrying capacity has been added, and strength, ruggedness, and resistance to corrosion and wear have been greatly enhanced.

All-high-strength-steel construction, with its superior strength and elastic properties, assures maximum protection for bus patrons in the event of accident. There are those who would like to make a virtue of a low modulus of elasticity, claiming that in the event of accident, whether it be severe or not, denting of panels is localized and damage much easier to repair. In the event of an accident I can see no virtue whatsoever in localizing as a puncture what normally would be a dent, because no one can predict what the results of a puncture are likely to be. With a dent, whether it is localized or not, there is still a piece of substantial steel between the denting agent and the bus rider. Steel panels come cheap, lives do not.

Related to the foregoing mechanical properties of high-strength steels is another property of outstanding importance which is sometimes overlooked —that is, strength in shear. A shearing force in any section is one which tends to produce slippage along the given section. Such forces come into play on both loaded and unloaded truck bodies and trailers on hills and on uneven roads. Those forces are relatively unimportant in unloaded bodies but they become quite important when loads are involved, especially when the driver is forced to use his brakes suddenly, or when the load shifts for any reason. Shearing forces are nearly always highly localized. In the case of riveted bodies such forces are far more destructive than they are with welded bodies because the shear strength of properly executed welds of all kinds closely approaches that of the parent metal.

The strength in shear of low-alloy high-strength steel in the as-rolled condition is approximately 52,000 psi, some five times greater than common nonferrous structural metals.

This superior shear strength of high-strength steels, coupled with their higher tensile strength, has led to their use in the southwestern oil fields for the main stress frames of auto aligning equipment. This equipment, similar in appearance to a garage grease rack, acts as a frame to which levers, screws, hydraulic jacks, wrenches, and chains are fixed to realign heavy trucks, diesel trailers, and tankers. Without high-strength steel, these units would require more bulky carbon steel members with consequent higher foundation costs, somewhat larger buildings, and heavier motive power.

The shear strength of these steels has made them popular, too, for U-bolts, end-gate hinge pins, and stake braces on many kinds of trucks and trailers.

Weight Saving is Only One of Many Advantages.

There are other mechanical properties in which high-strength low-alloy steels excel which I could discuss at length. These steels are characterized by high notch toughness, or the ability to withstand sudden blows without failure. Their ability in this respect is considerably greater than that of structural carbon steels. This ability to resist deformation under suddenly applied loads is of importance in maintaining a "tight" body on uneven roads, or under conditions which cause loads to shift suddenly.

For that reason, too, high-strength steels have special virtue when used to make rim sections for both trucks and passenger cars. Because these steels do save weight, have a high yield point, high impact strength, and high fatigue strength, their use in this service should be more closely examined. Also, their superior corrosion-resistant properties suggest their use to ensure maximum safety when tubeless tires are employed.

High-strength steels also have high abrasion resistance, up to 12 times that of low carbon steel, depending of course on service conditions. They can take a severe beating in service without losing sufficient metal to render the structure dangerous because of metal loss, either generally or locally. That characteristic is coupled with a rare ability to resist battering and piercing.

In addition to the foregoing virtues of high-strength steels at room temperature, they have properties superior to those of structural carbon steels at low temperatures. When structural carbon steels and high-strength steels are subjected to low temperatures, their strength, elasticity, and endurance limits are steadily increased, with little change in ductility. High-strength steels exhibit greater notch toughness than carbon steels as the temperature drops. As a matter of fact, high-strength steels retain their notch toughness to the lowest temperatures ordinarily encountered in serv-

ice. The degree of this toughness is much greater than that of any common nonferrous structural metal. This low-temperature toughness characteristic ensures satisfactory body performance over the wide temperature range of the United States and Canada.

The reason for the superiority of these low-alloy steels at subzero temperatures is the fact that the alloying elements are largely dissolved in the iron matrix much as sugar dissolves in water. Therefore the strength of the steel is not altogether dependent upon its carbon content, as is the strength of plain carbon steels. As a matter of fact, Admiral Richard E. Byrd's Antarctic Snow Cruiser was made almost entirely from one of these high-strength low-alloy steels.

In the other direction, high-strength low-alloy steels maintain their high strength characteristics at moderately high temperatures. At 1200 F, for example, these steels will exhibit a tensile strength of approximately 21,000 psi, a yield point of 12,000 psi, and an elongation in 2 in. of about 60%. These characteristics are sufficiently high to ensure the holding together of a structure, even under severe fire conditions.

These Low Alloy Steels Last Longer, Handle Easier.

In addition to higher tensile properties, the alloy additions to these steels have imparted added corrosion resistance over carbon steels and copper steels. Such elements as nickel, chromium, copper, and silicon are known for their individual effects in increasing corrosion resistance of steels in unfavorable environments. The combination of the above elements in small amounts, particularly the combination of copper and phosphorus in high-strength steels has proven successful in increasing their corrosion resistance in extensive test exposures to marine and industrial atmospheres. High-strength steels have atmospheric corrosion resistance equivalent to about a 5% chromium steel and lose one-sixth as much weight per year compared to carbon steels or one-third as much compared to copper steels.

The use of such information in predicting longer life, is difficult to evaluate because rarely is a steel placed in service as it is found on corrosion test racks. Cold working of metal, galvanic action caused by joining dissimilar metals and the joints themselves, and the necessity of having to ground a structure introduce some variable not found on test racks. Nevertheless experience has shown that some correlation does exist between performance of materials exposed on test racks and the performance of materials under actual service conditions.

The use of high-strength steels in the manufacture of dump trucks, delivery trucks, tank trucks, railway hopper cars, and slag cars has shown over the past 10 years that longer life has been obtained because of increased corrosion resistance. High-strength low-alloy steels have done an excellent job in resisting the corrosion caused by the use of salt or calcium chloride on streets to melt snow. Their use is also suggested for mufflers and fuel tanks.

There is another aspect of corrosion which should be mentioned, however. It is called corrosion fatigue. Not much is known about it yet. We do know, however, that its effects are greater than the sum of the effects of corrosion and repeated stress acting independently. Some experimental work has been done on it; more is in progress. In one series of tests high-strength low-alloy steels have shown failure values of 37,000 psi when repeatedly stressed in brine and 22,900 psi when repeatedly stressed in sulfide solutions. We believe those values have not been exceeded in such tests by any structural metal except stainless steel for the use under discussion. They should be of important interest to those whose truck bodies are used for delivery of merchandise which involves moisture, such as milk and truck garden produce. It is also suggested that high-strength steels may find use as fan blades and engine mounts.

The life of low-alloy steel, or any other steel for that matter, can be materially increased by painting. Adherence of paint to these steels is excellent, being superior to the adherence to plain carbon steels. In addition they can be prepared for painting by ordinary degreasing methods. The finish coat is often applied directly without the use of a primer.

Possibly the greatest virtue that high-strength low-alloy steels possess which is of direct interest to truck and body manufacturers is the fact that they can be processed so easily by standard methods on conventional equipment. It is true that because of their higher yield strength it may be necessary to have higher applied forces on drawing dies, bending brakes, punches, shears, and the like. But generally speaking, the fact that lighter gages may be used than are used with plain carbon steels obviates this condition. However, their greater springback must be given some consideration, and greater die clearance and radii of bends may be necessary.

High-strength steels are sufficiently ductile to be used for many of the most difficult drawing jobs. Many such jobs have been done in the past 10 years on dies which were designed for plain carbon steel, with a consequent output of more parts per ton because of the lighter gage of steel involved. In shop operations such as reaming, sawing, milling, drilling, or ordinary machining, little or no change is necessary in the equipment after a few experimental pieces have been worked by the shop crew.

The fact that high-strength low-alloy steels can be deep drawn gives the designer great latitude in styling. Many parts can be so fabricated as to perform the double function of acting as a structural member and also conferring beauty to the structure.

Of course, high-strength steels can be flame cut to shape, either in individual pieces or in gangs, without damage to the material and with a somewhat more smooth and even flame cut edge than is possible to achieve with plain carbon steels. This is an important fact to consider in connection with the manufacture of heavy-duty truck and trailer body frames which must have exceptional toughness and high elastic properties.

But the greatest virtue, in the shop, of high-strength steels is their weldability. They can be easily welded by any of the readily available commercial processes, including shot welding. Their

alloy content has been so adjusted that there is a minimum of metallurgical damage done by welding in the heat-affected zone. The weld picks up sufficient alloys from the parent metal to reduce effectively the possibility of weld corrosion. These facts are, of course, of extreme importance not only in original fabrication but more so in maintenance. Shot welds can be readily taken apart with a cold chisel, and panels or other parts damaged badly by accident can be removed by torch cutting without affecting any other part of the vehicle. Of course, new panels or parts of panels can be readily and economically installed in the field.

Dents and other types of mechanical damage do occur in all kinds of auto bodies. They are harder to inflict on high-strength low-alloy steel because of its inherently greater strength. A pierced dent chargeable to normal operations is a rarity. All types of dents and other minor mechanical damage can be removed rapidly and economically in the field.

Low-alloy high-strength steel does not have to be babied on the production line. No special handling methods or equipment need be employed to take care of it because it has what it takes to take care of itself. In addition, the advantages of magnet handling are important in many production operations.

(Paper on which this abridgment is based is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

New Air Cleaner . . .

. . . for combat vehicles features 99.7% efficiency and low initial restriction. It will be improved further by integration with a precleaner.

Based on paper by **Edward Blackburne and C. R. Denton,** Detroit Arsenal

SEARCH for a combat vehicle air cleaner better than existing oil bath types has led to the development of a very promising dry type with felt element (Fig. 1). When used in conjunction with a precleaner, the rise in efficiencies and length of service life indicate that it will fill the need created by higher speed engines with their increased demand for air.

In field tests with a standard tank, a standard oil bath cleaner was used for one bank of the engine while a test model dry type cleaner, without precleaner, was used on the other bank. The oil bath cleaner had a dust capacity of 24 hr of service life while the dry type cleaner had one of 27 hr. Efficiency of the oil bath type was 98% as contrasted with 99.7% for the dry type.

Dust which collected on the felt element during a high speed run would drop from the element as the tank slowed down and the air flow decreased to idle air demand. Actually, engine and vehicle vibration caused the dirt to fall out of the filter.

Development is now going forward on a dry type felt element integrated with a precleaner which has a self-dumping feature. The precleaner on this combination needs no servicing because the dust collecting at the bottom is discharged into the atmosphere by the engine cooling fans. Early tests indicate a greatly increased service life while operating at an efficiency of 99.3%. However, much work remains to be done before a final design can be released for production. (Paper "Air Cleaners for Military Vehicles" was presented at SAE Automotive Ordnance Day, Detroit Arsenal, Center Line, Mich., Feb. 28, 1955. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

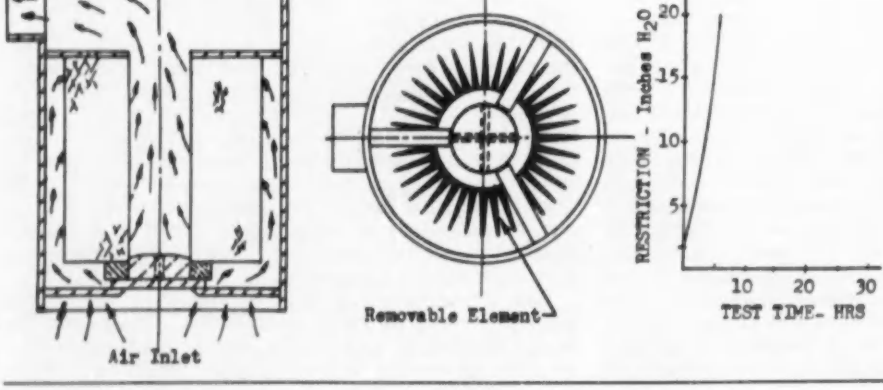


Fig. 1—This dry type air cleaner with felt element, developed for military vehicles, has an efficiency of 99.7% and a low initial restriction. In process of development is a model integrated with a precleaner having a self-cleaning feature.

Getting the Most Out of

Gear Cutting and Heat Treating

C. Seidl, Wisconsin Axle Division, Rockwell Spring & Axle Co.

Based on secretary's report of Gear Cutting and Heat Treating Panel, held as part of the Production Forum at SAE National Tractor Meeting, Milwaukee, Sept. 13, 1954.

NEW ideas and techniques on how to cut and heat-treat gears are constantly being sought. Here are some recent ones that have proved helpful to men in the field:

On Design . . .

The American Gear Manufacturing Association recommends standards and tolerances for gear tooth profiles and other dimensions for various ranges of speed. It also sets tolerances for hob gears, shaped gears and shaved gears. It groups gears into four classes of tolerances depending on pitch line feet per minute.

A full depth tooth gives a better overlap and smoother operation than a stub tooth which sacrifices overlap to get stronger teeth. Experience and experiments show that a 1.2 overlap is better than 1.4.

Helix and pressure angles must be able to carry the load quietly and still be within manufacturing capabilities. Sharp corners at roots should be avoided.

On Noise . . .

Noise is a big problem in transmission gears. Some noise comes from causes before heat treating, some from after heat treating. Accurate gear tooth geometry is very important to get quiet gears. When a lot of gears is processed through heat treating, if they are uniform, distortion can be predicted. Then the lead and involute angles can be modified to compensate for heat-treat distortion.

On Forging . . .

Good forgings are essential for good gears. If forging dies become washed out, the metal flow pattern is affected. Then during final heat treatment there is distortion. Billet size and blank size must be carefully controlled. Practice and experience will determine how many pieces can be forged from a die before reworking it.

On Core Hardness . . .

The ideal core hardness is between 30 and 35 Rc. 44 Rc is too high for a thin gear although it may be all right for a heavy sectioned gear. Below 25 Rc is very undesirable.

To avoid distortion and to obtain the best properties of toughness, gears should be carburized to a carbon potential of .87 to .92% carbon. Then they should be quenched. Distortion is a function of

The panel "Getting the Most Out of Gear Cutting and Heat Treating" was divided into two sections:

Gear Cutting:

A. S. Black, Fellows Gear Shaper Co.
F. Bohle, Illinois Tool Works
I. Kamlukin, Simplicity Mfg. Co.
C. Staub, Michigan Tool Co.
J. C. Straub, American Wheelabrator Co.
L. H. Seyfer, International Harvester Co.
W. Y. Cowell, Gleason Works

Heat Treating:

L. W. Steege, John Deere Waterloo Tractor Works
L. E. Webb, Clark Equipment Co.
V. Erickson, Allied Metal Treating Corp.
E. D. Hunt, Massey-Harris Co.
T. A. Frischman, Eaton Manufacturing Co.
N. O. Kates, Lindberg Steel Treating Co.
D. J. Wright, Caterpillar Tractor Co.

Panel leader:

B. W. Keese, Wisconsin Axle Division, Rockwell Spring and Axle Co.

Panel secretary:

C. Seidl, Wisconsin Axle Division, Rockwell Spring and Axle Co.

core hardness which in turn is controlled by the temperature at which the gears are quenched. Therefore, after carburizing at a temperature of 1680 to 1700 deg F, the temperature is dropped to a range where the desired core hardness is obtained.

Splined gears can be kept soft by blocking off carburization. A group of gears is locked together, separated by ¼-in. copper washers. A perforated stainless tube containing scale reacts with any carburizing gases which may seep into the bores.

On Case Hardening . . .

There is no exact formula for the proper case hardening depth of a gear. Thickness is determined by past experience and it is most important. Excessive case depth can reverse the favorable compressive stresses of the case and leave unfavorable tensile stresses. Effective case hardened depth is the depth at which a Turkon Hardness Tester can measure 50 Rc.

On Flame Hardening . . .

Alloys such as 8645 and 8642 are flame hardened. Bore shrinkage is inevitable, therefore enough bore stock should be allowed for finishing later. Hardening must penetrate below the tooth roots or they will fail.

On Induction Hardening . . .

Plain carbon steel such as 1045 is induction hardened by either of two methods: carburizing or full hardening. Induction hardening permits the use of push-out broaches, and give less distorted, longer lasting gears. It can hold splines and controls residual stresses.

Growth across the tips of the gear tooth is a problem in both flame and induction hardening and can cause pinion failures.

On Tempering . . .

Tempering after heat treatment is recommended as a safety measure. It's good insurance against chipping and is essential in gears which are to be ground after heat treatment. This is because untempered martensite will develop cracks from the heat of the grinding wheel. However, if the gear has been correctly hardened so that there is no ferrite-bainite-martensite structure in the core, it can carry a greater load untempered.

Bainite and martensite structures are always present to some degree and give satisfactory strength and wear. But tempering will insure dimensional stability. Although tempering carburized pieces is not essential, they should be removed from the quench while still hot (250–300 F) to avoid excessive stresses.

Hot salt quenching gives more uniform results than oil quenching. But it is limited to light sections. Preliminary laboratory tests show that better tooth contact can be obtained with parts that have been salt quenched.

Hardness specifications usually call for 55 Rc minimum at 0.090 in. depth at the root. The method of hardening depends upon the use to which the gear will be put.

On Shot Peening . . .

Even after carburizing and hardening, shot peening is beneficial. Residual compressive stresses greatly enhance fatigue strength. The shot need not be as hard or harder than the gear. Steel shot with 45 Rc hardness is just as effective as chilled iron shot and is more economical because it lasts longer.

The greater the tooth thickness the greater should

be the peening intensity. The metal is affected to about 0.010 in. depth. Uniformity and good coverage is essential.

Peening does not change dimensional accuracy to any appreciable extent.

In some cases both gears and pinions are peened. Peening will increase allowable stress 10 to 80%. And it can improve fatigue life from 3 to 30 times.

On Shaving . . .

Gear shaving is a finishing operation to improve the gear quality by removing small amounts of material from the working surfaces.

Shaving is not intended to be a salvage operation. It will not remove an error due to careless cutting. But involute and lead errors not removed by previous cutting operations may be corrected by shaving.

Crown shaving helps localize the tooth load. It puts the contact and localized bearing area in the center of the tooth instead of on the ends. Too much shaving will shorten the area of tooth contact and may cause failure due to compressive overloading. Generally 0.001 of the crown per inch is sufficient for automotive and tractor gears. 0.002 is excessive because the contact will not spread to the ends under load.

A single shaving cutter cannot be used for all ranges of teeth because requirements vary with the various gear designs. If the cutter has a prime number of teeth (in relation to the number of teeth being cut) the inaccuracies in the cutter teeth will cancel each other out after a few revolutions of the piece.

When a close involute tolerance is required, different shaving cutters are used; one for every three or four tooth increases.

Generally, material can be shaved if it has a Rc of 34 to 36. Any burrs on the gear teeth will disturb the shaving action and affect the finished part. If a cutter could be found which would not wear out, shaving *after* carburizing would be ideal. Even cutting tools up to 66 Rc can't stand up under those conditions.

Shaving will improve the finish of a tooth up to 50%, and it eliminates inaccuracies on hobbed teeth. Burnishing hypoid gears isn't absolutely necessary, but it will smooth out cutter marks and eliminate whistle noises.

Before shaving, a good hobbing machine is necessary to produce accurate gears. Index and feed gears and cams must be checked periodically for accuracy. Tungsten tipped hobs are fine for certain types of marine gears, but are not practical in a production shop.

(The report on which this article is based is available in full in multilith form together with reports of six other panel sessions of the Production Forum held in Milwaukee, Sept. 13, 1954. This publication, SP-308 is available from the SAE Special Publications Department. Price: $1.50 to members, $3.00 to nonmembers.)

Business Aircraft . . .

. . . is a profit maker, not a luxury. Manufacturers should focus attention on factors producing dependable flight hours.

Based on paper by **Cliff Titus,** Beech Aircraft Corp.

THERE is just one reason for the existence of business aircraft: it is to fly. If the airplane is not immediately available for flight, or not airworthy, it is as useless as a doctor's car in a garage with a flat tire.

Flight hours are as essential to the making of a profit by the manufacturer of business aircraft as they are to the profit of the owners and users. To fly and generate flight hours, planes, parts, and services must be readily available and dependable.

We, as manufacturers of these airplanes, must consider production with quality thinking, planning, and workmanship from the first blueprint to the last rivet and accessory.

The supply of parts must be adequate and their delivery reasonable.

Cost, too, is a vital item. The businessman who uses our product demands to know that the aircraft he buys costs no more than it should and he has a right to know why business planes cost as much as they do. His profit depends on the cost of the plane in relation to his sales. Our profit in the industry depends on the ratio of cost to our sales. Budget control is essential to the production of profitable flight hours.

Safety is a first and major factor. We use the term "margin of safety" because there is no usable measure of absolute safety. The businessman demands a constant increase in that margin.

Sales, dependable service, and overhaul facilities should be available anytime, anywhere.

We need to consider the steady demand for improvement. Quoting E. Tilson Peabody of General Motors: "All but one or two of our aircraft types have reached the limit of weight and space provisions. Any addition of radio, instruments, or equipment requires costly re-arrangement if there is any space at all, and weight limitations can be met only at the cost of gasoline load. Weight control has now become a major problem and considerable sales resistance can be anticipated if appreciable weight increase will result from the installation of additional equipment."

All this adds up to a great challenge. Our profit, our bread and butter, our future, depend on how well we meet the challenge.

(Paper "The Growing Importance of the Businessman's Aircraft" was presented at SAE Wichita Section, Nov. 12, 1954. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

New V-8

Packard V8

W. E. Schwieder, Packard Division, Studebaker-Packard Corp.

Based on paper "The New Packard V-8 Engine" presented at SAE Golden Anniversary Passenger Car, Body, and Materials Meeting, Detroit, March 2, 1955. This paper will be published in full in 1956 SAE Transactions.

IN PLANNING the Packard V-8, the primary objective was to design into this new engine the best features that present technical knowledge permitted. Also, to provide sufficient flexibility to incorporate future changes as better fuels become available, and increasingly higher compression ratios become practicable. How successfully the new Packard V-8 engine meets the original objectives is summarized, as follows:

a. **Basic Design:** Exceptionally free breathing through painstakingly designed passages. Overhead valves 25% larger in head area than those used in the 1954 engine to provide maximum volumetric efficiency. Incorporates short stroke, low friction characteristics to increase mechanical and thermal efficiencies, culminating in higher performance and greater economy and longer life.

b. **Physical Characteristics:** New configuration offers mechanical and functional simplicity, allowing more flexibility for future styling trends and providing accessibility for servicing. Greatly increased rigidity, amply provides for future operation on improved fuels at compression ratios above 12/1.

c. **Displacement:** About the same as its predecessor, and potentially capable of being enlarged beyond the displacement obtainable with any other 1955 automotive engine, indicating extremely conservative design in anticipation of possible future requirements for still greater power and torque.

d. **Combustion System:** Highly turbulent, wedge-type, elliptically shaped combustion chamber, permitting knock-free operation on improved fuels at compression ratios over 12/1.

e. **Stroke-Bore Ratio:** Extremely favorable stroke-bore ratio of .875 gives a reduction in piston travel

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Discussion of Combustion

There was a lively discussion of the relative merits of the modified hemispherical combustion chamber and the wedge-shaped chamber after the presentation of the new Packard and Plymouth V-8 engine papers, at the Golden Anniversary Passenger Car, Body and Materials Meeting, Detroit, March 2, 1955. The discussion is summarized below:

W. D. Appel, consulting engineer: Why do these two new V-8s have radically different combustion chamber configurations?

H. L. Welch, Chrysler Corp.: Chrysler tests and investigations favored the hemispherical type chamber because combustion roughness was low and it gave good detonation control. Also, it had high thermal efficiency and was capable of the highest volumetric efficiency. The Plymouth engine uses a modified hemispherical type which retains most of the advantages of the true hemispherical. It was modified to simplify and reduce weight.

W. E. Schwieder, Studebaker-Packard Corp.: Packard selected its wedge-shape design because tests showed it best satisfied driver requirements. It had good low-range torque characteristics. Also, it was very efficient and had good detonation control.

Appel: Is bore size a factor in determining the particular design?

Welch: Stroke/bore ratio is a factor. As the stroke is increased the advantage of the hemispherical chamber is increased.

PLYMOUTH V-8

H. L. Welch, Engineering Division, Chrysler Corp.

Based on paper "The New Plymouth V-8 Engine" presented at SAE Golden Anniversary Passenger Car, Body, and Materials Meeting, Detroit, March 2, 1955. This paper will be published in full in 1956 SAE Transactions.

Chamber Shape

reported by technical session secretary, **H. R. Johnson,** Studebaker-Packard Corp.

Schwieder: Bore size was not the particular influence in Packard's combustion chamber design. Packard had investigated a number of bore sizes in developing the new engine.

Appel: Is there a great similarity between the Chrysler and Plymouth combustion chambers?

Welch: Yes, there is. Although the Plymouth chamber was modified for simplicity, it retained the basic features of the Chrysler type. The spark plug and valve locations are very similar, and although compact, there is ample room for 1 23/32 in. diameter inlet valves and 1 15/32 in. diameter exhaust valves for a bore size of 3 9/16 in. diameter.

Achilles C. Sampietro, Thompson Products, Inc.: Since the swept volume varies as the square of the bore and directly as the stroke, while valve area varies directly with valve diameter, isn't the combustion chamber design somewhat dependent on cylinder size?

Welch: Yes. The greatest factor is the stroke/bore ratio for usual automotive-size engines. A low stroke/bore ratio, or small cylinder size for a given stroke/bore ratio, makes it easier to obtain adequate valve sizes with valve-in-line combustion chamber designs. The hemispherical chamber provides room for larger valves which becomes increasingly beneficial as cylinder size or stroke/bore ratio are increased.

IN DESIGNING its new V-8, Plymouth adopted some of the features which had already proved successful on the other Chrysler Corporation cars. Perhaps the most significant is the use of a modified hemispherical combustion chamber.

The new Plymouth engine is a 90 deg V-8, having a bore and stroke of 3.563×3.25 in. and a piston displacement of 259.2 cu in. Compression ratio is 7.6/1. The dry weight of the engine, including air intake silencer, starter, generator, and fan, (but not flywheel) is 568 lb. Overall length is 29⅜ in.

Hemispherical combustion chamber

A hemispherical combustion chamber has the following advantages:

1. Maximum thermal efficiency for a given compression ratio.
2. Maximum volumetric efficiency.
3. Excellent valve seat cooling and freedom from distortion.
4. Lowest loss to carbon deposits.
5. Lowest heat loss to cooling system.
6. Excellent detonation control and freedom from deposit-inspired preignition.
7. Excellent response to increases in compression ratio.

Without attempting to fully explain the characteristics of this type of combustion chamber, it is believed that the main reasons for superiority may be summarized by:

(a) A compact chamber having the smallest surface/volume ratio.

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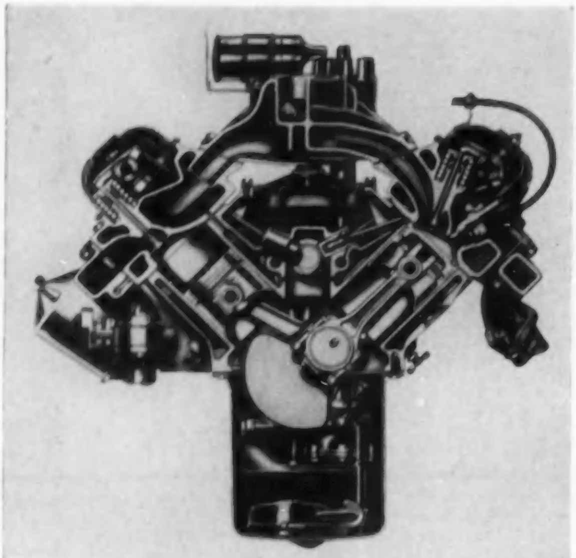


Fig. 1—Transverse section of the Plymouth V-8 shows the compact crankshaft, connecting rod, piston, and cylinder block structure.

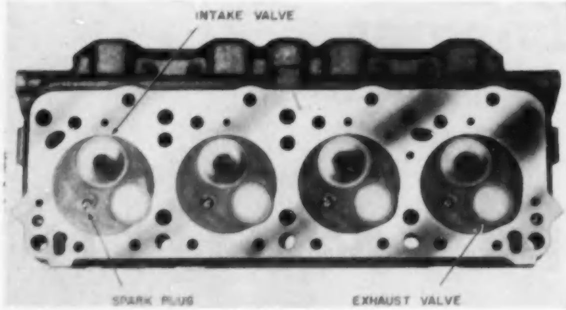


Fig. 2—The modified hemispherical combustion chamber is very similar to the hemispherical chamber. This shows the relative position of the valves and spark plug.

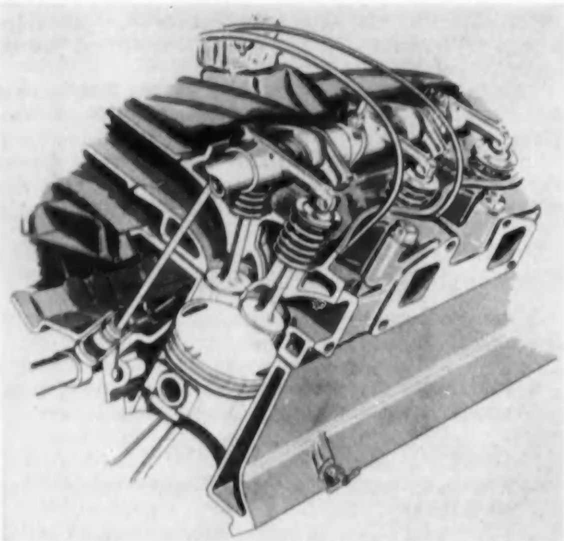


Fig. 3—Cutaway of the valve train shows intake and exhaust valves are on opposite sides of the rocker shaft.

(b) Good spark location, giving short flame travel.

(c) Capacity for large valves, and proper disposition of valves and ports to augment volumetric efficiency.

In the Plymouth V-8, strong consideration was given to use of a conventional chamber with rather small, closely spaced valves, making it compact, and similar in shape to a hemispherical chamber. This would have resulted in restricted power potential and questionable valve durability. When combined with a large bore and short stroke, it looked more attractive for valve size, but automatically meant a less compact chamber with lower thermal efficiency.

By re-orienting the exhaust valve, and placing it parallel to the cylinder axis, slightly off the transverse center plane of the cylinder, a combination was possible that closely approximated the compactness and large valves so characteristic of the hemispherical chamber. Of great significance is the fact that both the valves can be operated from a single rocker shaft, and the spark plug can be placed outside the rocker cover, but still in a very desirable position within the chamber. This modified hemispherical chamber design combines the simplicity of the conventional overhead valve types with most of the characteristics of the sought-after hemispherical chamber.

Experience with engines of widely varying stroke/bore ratio indicated very little change in mechanical efficiency over the range of 0.8 to 1.0. A noticeable trend was observed of a *decrease* in thermal efficiency as the stroke/bore ratio was decreased. Thus, while an ultra short stroke/bore ratio favors maximum attainable valve size, and minimum width, height and weight, a longer stroke/bore ratio enhances thermal efficiency and reduces length. When combined with the modified hemispherical combustion chamber, a stroke/bore ratio of 0.91 provided a light, compact, low friction design together with excellent thermal efficiency and performance.

Fig. 1 shows the modified hemispherical combustion chamber with streamlined intake and exhaust ports and the single rocker shaft valve operating mechanism. A saving in engine weight of 35 lb was achieved by this simplified cylinder head construction. The close similarity to the hemispherical chamber, including port shape and relative position of the valves and spark plug within the chamber are plainly visible in this view and in Fig. 2.

Valve train

The valve drive train is shown in more detail in Fig. 3. Intake and exhaust valves are on opposite sides of the rocker shaft, as are the respective push rods. Valve stems operate directly in the cylinder head iron and all valve seats are integral. Cylinder heads are cast of iron with chromium added to in-

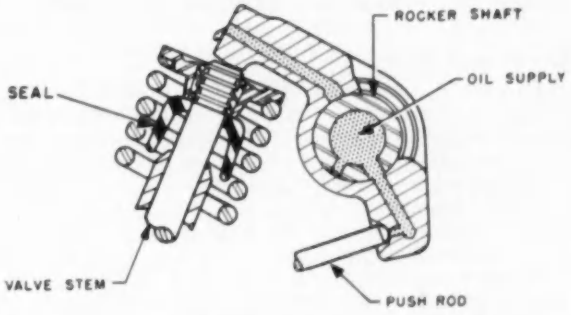


Fig. 4—Intake valve rocker is lubricated by oil at pressure less than main gallery pressure through the hollow rocker shaft. Drilled holes admit it to the push rod socket and valve stem.

sure a good wear resistant structure of the integral valve seat material. Right and left cylinder heads are identical for the convenience of service and manufacturing.

Intake valves of 8440 steel have a head diameter of 1 23/32 in. and are of modified tulip shape to conserve weight. Exhaust valves are made of Silcrome XCR and have a head diameter of 1 15/32 in. Stems of both valves are 3/8 in. in diameter for added strength and bearing area.

Push rods are solid, made from 1/4 in. diameter drawn steel wire. The machined spherical ends are induction-hardened to give long life. This type of push rod was selected on the basis of durability and valve gear dynamic tests, which showed these push rods to be the simplest, and lightest that gave adequate linear stiffness.

Single valve springs are employed. The cams provide quiet and smooth valve operation to 5000 rpm with moderate valve spring loads of 53 to 140 lb at valve closed and open positions, respectively.

Hydraulic tappets provide the important function of maintaining zero lash in the valve train for quiet operation and long trouble-free valve life.

Valve train lubrication

Lubricating the valve train parts without contributing to oil consumption is accomplished as shown in Fig. 4. Oil at pressure less than main gallery pressure is delivered to the hollow rocker shaft, from which it is admitted to the push rod socket and valve stem end of the rocker through drilled holes. To prevent oil from entering the combustion chamber past the intake valve stems, a synthetic rubber cup type seal is used on all intake valves, as shown.

Low friction valve lock

As an aid to long valve life, a new type of low friction valve lock has been developed. As shown in Fig. 5, the conventional valve spring retainer is used, but the lock and valve stem tip grooving have been changed. The new lock is made to have radial clearance with the valve stem with the two halves of the lock butted together, permitting the valve to turn freely with respect to the valve spring retainer.

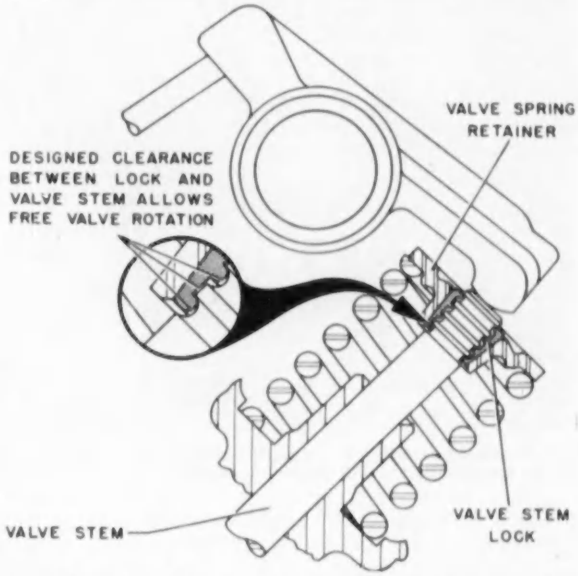


Fig. 5—Low friction valve lock is made to permit the valve to turn freely with respect to the valve spring retainer. Four lands give long life and high strength.

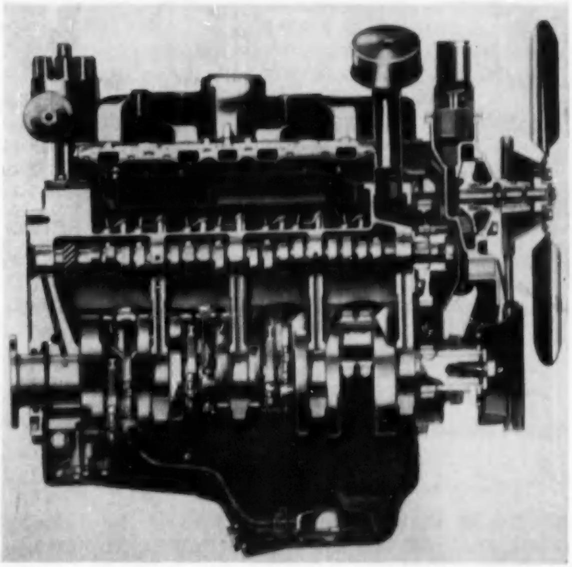


Fig. 6—Longitudinal section of the Plymouth V-8. Crankshaft is only 25 in. long, weighs 50 lb.

Four lands are provided to give long wearing life and high strength. Since contact between lock and valve stem is at a smaller diameter even than the valve stem itself, the torque required to turn the valve is very low.

Block and crankshaft

In Fig. 6, the longitudinal section of the engine reveals the very rigid cylinder block and crankshaft structure. The crankshaft is only 25 in. long and

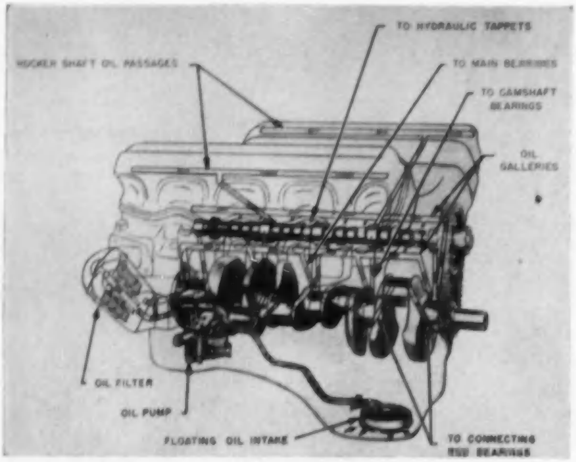


Fig. 7—Lubrication system is the same, basically, that has been used on the Chrysler, DeSoto, and Dodge V-8 engines.

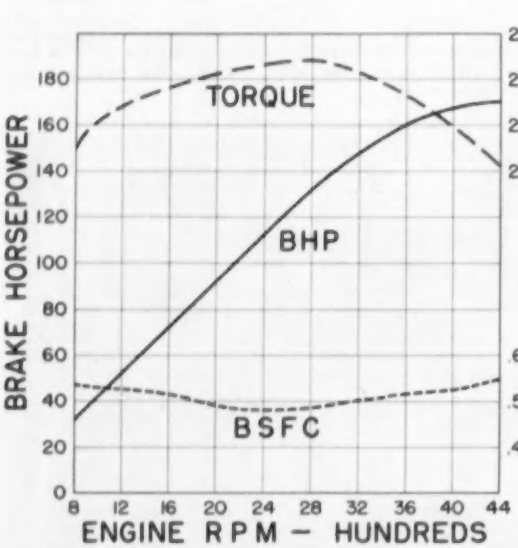


Fig. 8—Performance characteristics of Plymouth V-8.

has $2\frac{3}{8}$ in. main journals, and 1 15/16 in. diameter crankpins. Made from a steel forging, the crankshaft has a natural frequency in torsion of 293 cps and weighs 50 lb. All fillets between bearing journals or crankpins and cheeks are turned by a formed tool, and shotpeened before the final grinding operation. Thus all important fillets are accurately controlled for both size and shape, as well as being work hardened and residually stressed in compression for greater fatigue strength.

All connecting rod and crankshaft main bearings are micro babbitt, with steel backs. Lead base babbitt is employed except for the flanged No. 3 main bearing which takes thrust. This particular bearing is made of tin base babbitt which has excellent resistance to wear under thrust loading. By locating the thrust bearing in the No. 3 position it is practicable to lubricate the flanges generously without affecting the performance of crankshaft oil seals.

Crankshaft seals

The front crankshaft oil seal is a very positive design comprising a slinger, internal trough, and spring-loaded lip-type seal. To insure long life of the seal a rotating felt and slinger on the crankshaft pulley hub keep water and abrasive material from entering from the outside. The rear crankshaft oil seal is equally effective. A circumferential drainage groove near the rear edge of the No. 5 crankshaft bearing returns almost all of the oil to the crankcase that would otherwise flow out the rear of the No. 5 main bearing. The crankshaft slinger and ample slinger cavity further divert oil at this point, leaving the rope type rear seal with very little oil to handle. Diagonal knurling on the crankshaft at the location of the rope seal adds a pumping action that makes the rope seal very effective.

Camshaft and timing chain

The cast alloy iron camshaft is made exceptionally stiff in the interest of good valve gear dynamics. The cams are ground with a taper to produce reliable tappet body rotation. An extra wide $1\frac{1}{8}$ in. timing chain is employed together with means for reliable, directed lubrication to insure long life of the timing drive under all driving conditions. The separate, fuel pump drive eccentric is mounted on the front end of the camshaft and is doweled to the camshaft sprocket hub. It is lubricated by spray from the timing chain.

Coolant circulation

The water pump is fitted with ball bearings for long life and quiet operation. The pump delivers coolant into each bank of the cylinder block, from which it flows into the cylinder heads through calibrated holes in the deck.

Crankcase ventilation

The engine is ventilated by air drawn through the filter cap on top of the oil filler pipe. The cavity in the block at the bottom of the oil filler pipe communicates with the timing chain housing and thence to the crankcase. The stamped steel cover over the center of the cylinder block contains a low velocity baffle to separate oil droplets from the ventilation air before it leaves via the conventional road draft tube.

Lubrication system

In Fig. 7 is shown a phantom view of the lubrication system. The pressure regulating valve is located within the oil pump housing, the excess pump capacity being recirculated. Oil from the pump travels through the pad-mounted filter or through the shunt to arrive at the main oil gallery, to the right of the camshaft. This main oil gallery supplies oil to crankshaft and connecting rod bearings as well as camshaft bearings and the hydraulic tappets in the right bank. The parallel, secondary oil gallery located to the left of the camshaft is fed from the front crankshaft bearing. The secondary

oil gallery supplies oil to the hydraulic tappets in the left bank. This is the same basic lubrication system that has been used very successfully on the Chrysler, DeSoto and Dodge V-8 engines.

Pistons and rings

Pistons are especially robust having very heavy vertical ribs between the pin bosses and head. Full floating piston pin construction with a steel backed bronze bushing in the upper end of the connecting rod is employed for optimum piston performance and ease of servicing. A steel band is cast into the piston skirt just below the ring belt, to provide excellent skirt clearance control under all operating conditions. As a further aid to quiet operation, the piston pin is offset 1/16 in. toward the thrust side of the piston. Pistons are tin coated to prevent scuffing.

Intake manifold

The two level intake manifold contains no pockets or sump in the intake passages which eliminates puddling and "flash" problems. The exhaust crossover passage connects the exhaust port of cylinder No. 4 in the right bank with the port of cylinder No. 5 in the left bank. This feature is for the purpose of minimizing exhaust interference with induction, with the firing order 1-8-4-3-6-5-7-2. A thermostatic control valve at the outlet of the right bank exhaust manifold regulates the exhaust heat to the intake manifold.

Performance characteristics

The new Plymouth engine is rated at 167 hp and 231 lb-ft torque. Using test conditions which are more directly comparable to other published ratings, namely blocking off the exhaust heat from the intake manifold, the output is increased to 170 bhp @ 4400 rpm, and 249 lb-ft torque @ 2800 rpm, as shown in Fig. 8. This specific output of 0.65 bhp/cu in. and 145 psi bmep is believed to be very creditable for an engine with a dual venturi carburetor. It should be noted that this output is developed with a modest compression ratio of 7.6, which was selected to give assured satisfactory operation on regular grade fuels.

Efficiency

The high specific output of the engine is a combined result of high thermal, volumetric, and mechanical efficiency, as shown in Fig. 9. The indicated thermal efficiency is calculated from the specific air consumption, and excels that of some competitive engines having 0.4 higher compression ratio. The volumetric efficiency is a natural result of ample valve sizes and well disposed ports, together with a moderately high lift camshaft (0.365 at valve) and a fairly free induction system. The high mechanical efficiency is visible proof of a satisfactory stroke/bore ratio and careful mechanical design.

Part throttle brake specific fuel consumption is shown in Fig. 10. Of great significance is the remarkably low specific fuel consumption at light loads. At half load for example, the specific fuel rate at 1200 to 3200 rpm is 0.50 to 0.52 lb per bhp-hour. This "flat" characteristic of the part throttle specific fuel consumption is important to road load fuel economy, and is the result of high mechanical efficiency as well as high thermal efficiency.

(Paper on which this abridgement is based is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

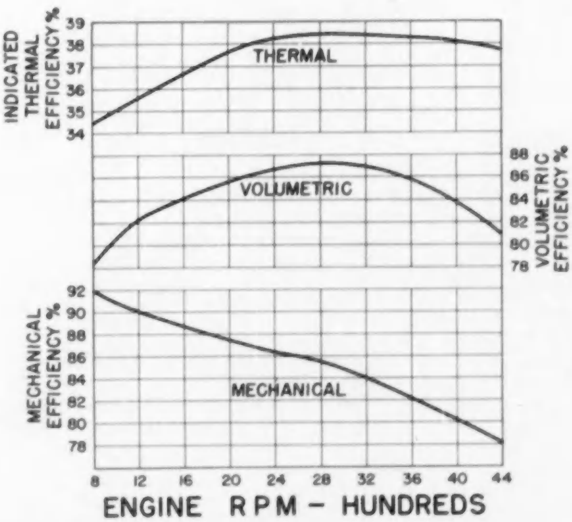


Fig. 9—The high specific output of the Plymouth V-8 is a combined result of high thermal, volumetric, and mechanical efficiency.

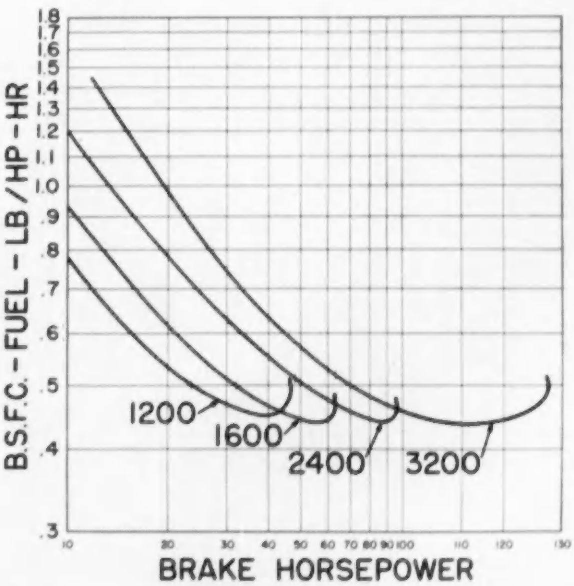


Fig. 10—There is remarkably low specific fuel consumption at light loads. In this graph, brake specific fuel consumption is plotted against observed horsepower for four different speeds.

Packard— continued from page 58

of 22% and accounts primarily for the higher power output of the 1955 Packard engine, since the displacement and compression ratio are about the same as the 1954 engine.

f. Performance: Overall performance greatly improved in comparison with the 1954 engine of essentially the same displacement and compression ratio, as follows: maximum bhp 22% and torque 7% higher, fhp 29% less at 4000 rpm, and bsfc 10% lower over the normal driving speed range. Potentially capable of meeting future requirements for higher output and more efficient operation without major alteration.

g. Durability: Ruggedness and durability proven under every condition, including a 25,000-mile endurance run during which all previous stock car records were eclipsed, setting a new standard for automotive engines.

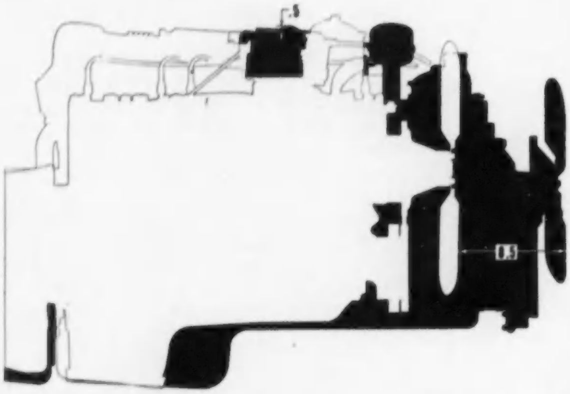


Fig. 1—Packard's new V-8 is shorter and lower than the 1954 engine. It is also somewhat wider.

Fig. 2—High turbulence, wedge-type combustion chamber provides a lower burning rate and avoids a high rate of pressure rise, resulting in freedom from roughness.

h. Producibility: Designed for manufacture by the most modern, efficient and economical methods, including automated machining, assembly and testing.

After establishing the basic design of the engine, considerable effort was devoted to locating the various engine components and accessories.

The cylinder block, cylinder head, and intake manifold were all designed to facilitate casting, machining, and assembly. In the location and arrangement of these items, as well as the various accessories, maximum mechanical and functional simplicity were considered extremely important to allow for ease of servicing and economy of manufacture.

The reduced height and length of the 90 deg V-8 engine greatly simplifies the chassis design and offers the body stylist somewhat more flexibility than was permissible with the 1954 straight-8 engine. However, the increased width of the 90 deg V-type of engine poses some clearance problems, particularly on the steering side of the engine compartment. Fig. 1 shows the new engine is ½ in. lower and 8½ in. shorter than the 1954 engine. Although the V-8 is somewhat wider, judicious arrangement of the other items also housed in the engine compartment eliminated any real difficulty from this standpoint.

Studies were conducted to insure that full advantage was taken of the inherently lighter V-8 design. A reduction of over 8% resulted from the introduction of the new engine. An even greater reduction in weight could have been obtained if compromises had been acceptable in the life and durability of this engine. Even so, it is evident that the new Packard V-8 engine compares very favorably with competitive V-8 engines on the basis of pounds-per-cubic-inch of displacement.

In addition to the direct savings resulting from the weight reduction, the new engine permits a somewhat more favorable weight distribution between the front and rear wheels of the car. Hence, by reducing the engine weight, an improvement has also been obtained in the amount of effort required for handling and steering the car.

Wedge-type combustion chamber used

The high turbulence, wedge-type combustion chamber, having an elliptical shape in the plan view, Figs. 2 and 3, was selected as being the most satisfactory for passenger car application. This design provides a lower burning rate of the charge and avoids a high rate of pressure rise, resulting in freedom from objectionable combustion roughness. By cooling the last part of the charge to burn in the shallow section of the combustion chamber, called the quench area, combustion can be effectively controlled and the octane requirements are minimized. Another important factor in favor of this type of combustion chamber is its adaptability for increasingly higher compression ratios without sacrificing smoothness.

The development of the combustion chamber for the new Packard engine is based on studies of combustion phenomena and the influence of turbulence,

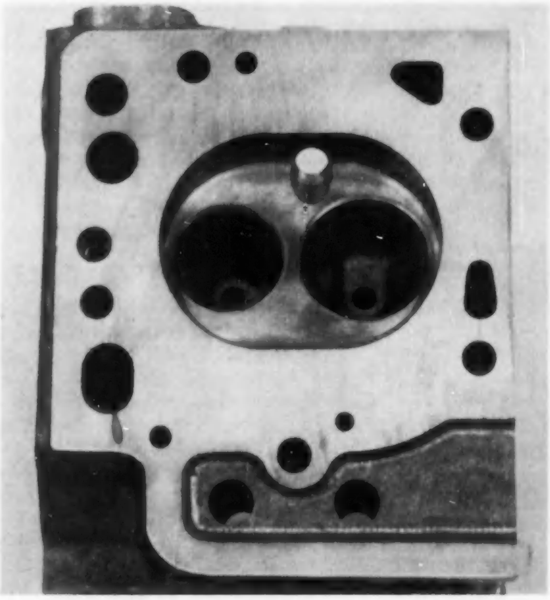


Fig. 3—Completely machined combustion chamber has an elliptical shape in the plan view. Valves are side-by-side.

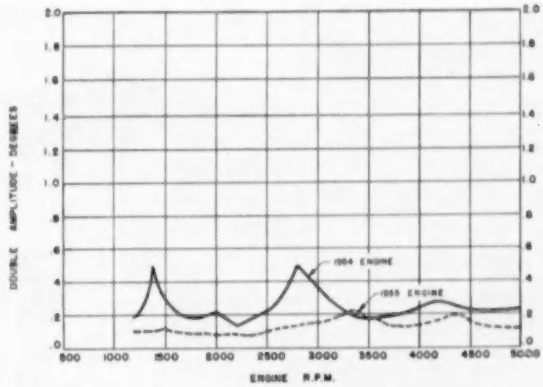


Fig. 4—Torsional vibration characteristics of the 1955 engine are greatly superior to the 1954 engine, primarily because the shorter crankshaft gives greater stiffness.

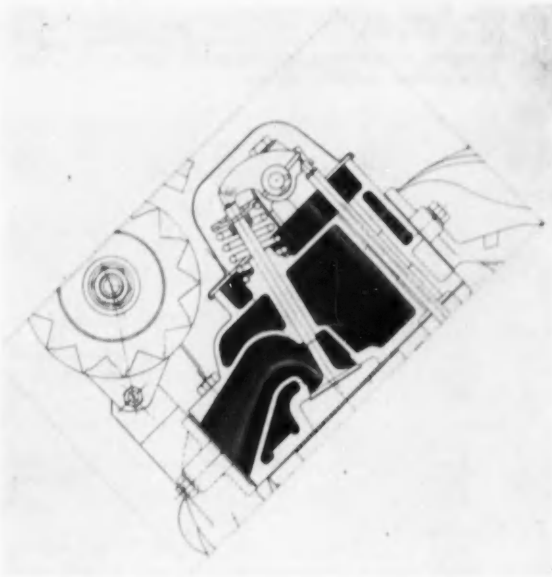


Fig. 5—Generous water packets are provided for cooling the valve seats, valve guides, and gas passages.

quench area, squish, spark advance, and other related factors. This work has culminated in a design remarkably insensitive to combustion chamber deposits which are so troublesome in other designs, particularly under light load city driving conditions, causing knock, auto-ignition, pre-ignition and running-on. The combustion chamber shape finally evolved is machined for accurate volume control and now gives outstanding performance. The quench area amounts to 20% of the piston coverage, and the nominal squish clearance is 0.045 in. with the piston at top dead center, as shown in Fig. 2.

Compression ratio is 8.5/1

After working with engines at various compression ratios all the way up to 12/1, a compression ratio of 8.5/1 has been established for the new Packard engine, based on the octane rating of the premium grade fuels now available throughout the country. At this compression ratio, continued satisfactory performance can be obtained even in the presence of substantial combustion chamber deposits. Ultramatic equipped cars can be satisfied with 94 octane fuel, even under the most severe prolonged light load city driving conditions.

Cast steel crankshaft

A cast steel crankshaft is used in the new Packard V-8 engine. Cast steel offers a sufficiently high modulus of elasticity as well as density to provide substantial savings in weight without sacrificing rigidity or stiffness. This type of crankshaft also permits disposition of the counterweights for maximum balancing effectiveness, and allows coring of the crank pins to minimize the amount of unbalance that must be compensated for by the counterweights.

By using the cast crankshaft, not only has weight reduction been obtained, but excellent manufacturing economies have also been realized.

By using a non-bonded rubber harmonic balancer, a suitable reduction has been obtained in the amplitude of crankshaft deflection, providing satisfactory performance throughout the normal operating speed range. As shown by Fig. 4 the torsional vibration characteristics of the new engine are greatly superior to the 1954 engine. The increased stiffness offered by the short crankshaft accounts primarily for the improvement despite the higher output of the new V-8.

Cylinder heads

The cylinder heads are conservatively designed, having greater height, width, and length than other competitive designs using a similar type of combustion chamber. Generous water jackets have been provided for adequately cooling the valve seats, valve

The New Packard V-8 Engine

SPECIFICATIONS

General

Type	OHV, 90 V-8
Bore, in.	4.0
Stroke, in.	3.5
Stroke-to-Bore Ratio	0.875
Displacement, cu in.	352
Compression Ratio	8.5/1
Designation of Cylinders	
Left bank, front to rear	1-3-5-7
Right bank, front to rear	2-4-6-8
Firing Order	1-8-4-3-6-5-7-2
Maximum Gross Brake Horsepower*	260 @ 4600 rpm
Maximum Gross Torque, lb-ft*	355 @ 2400-2800 rpm
Maximum BMEP, psi	152.1 @ 2600 rpm
Piston Travel, ft/mile	1480
Engine Weight, lb	698

*Corrected to SAE standard conditions of 29.92 in. Hg. atmospheric pressure and 60 F dry air.

Piston, Rings, and Pins

Piston	
Type	Autothermic, cam ground, slipper skirt
Material	Aluminum alloy
Weight, g	702
Piston Rings, Compression	
Number	2
Type	Thick wall, taper face
Material	
Top	Alloy iron, chrome plated
Intermediate	Alloy iron, Ferrox coated
Width, in.	0.078
Piston Rings, Oil	
Number	1
Type	Open slot, ventilated, w/expander
Material	Alloy iron
Width, in.	0.186
Piston Pin	
Type	Full floating
Material	SAE 1117
Size, dia., and length, in.	0.980 x 3.250

Connecting Rod

Center-to-Center Distance, in.	6.781
Length-to-Stroke Ratio	1.937
Material	SAE 1041 steel
Weight w/Piston Pin Bushing, g	757

Lubrication System

Lubrication System, type	Full-pressure
Oil Pump, type	Gear
Oil Intake, type	Floating
Oil Pressure, max., psi	50
Oil Filter, type	Partial flow
Crankcase Capacity, Less Filter, qt	5

Valve Train

Camshaft	
Material	Hardenable alloy iron
Bearings, No.	5
Drive, type	Chain
Width, in.	1.000
Pitch, in.	0.375
Cams	
Width, in.	0.500
Taper, min	6
Lifters	
Type	Hydraulic
Body	
Material	Hardenable alloy iron
Diameter, in.	0.904
Face, spherical radius, deg	30
Push Rods	
Material	Steel tubing
Size	
Diameter and wall thickness, in.	.375 x .065
Length, in.	10.506
Ends, spherical radius, in.	0.250
Valve, Intake	
Material	Silichrome #1 steel
Head diameter, in.	1.937
Stem diameter, in.	0.3725
Seat angle, deg	30
Valve, Exhaust	
Material	2112 austenitic steel
Head diameter, in.	1.687
Stem diameter, in.	0.3715
Seat angle, deg	45
Rocker Arm	
Material	Pearlitic malleable iron
Ratio	1.60
Valve Lift, in.	0.375
Valve Spring Load	
Closed, lb	82
Open, lb	165
Valve Timing	
Intake opens, deg btc	14
Intake closes, deg abc	56
Exhaust opens, deg bbc	52
Exhaust closes, deg atc	18

Crankshaft

Main Bearings, No.	5
Counterweights, No.	6
Over-all Length, in.	27.344
Connecting Rod Journals, dia., in.	2.250
Connecting Rod Effective Bearing Area, sq in.	52.8
Main Bearing Journals, dia., in.	2.500
Main Bearing Journal Effective Area, sq in.	38.6
Bearing Journal Overlap, in.	0.625
Rough Casting Weight, lb	65
Machined Casting Weight, lb	56

guides, and gas passages, Fig. 5. Conventional casting methods are used in making the cylinder heads, and the experimental design has been successfully translated into production. The cylinder heads are interchangeable and are attached to the cylinder block by 15 screws appropriately spaced so that 5 screws surround each bore. Tension loads are transferred to the bulkheads in the cylinder block by this arrangement, permitting the use of a thin, one-piece, embossed, steel gasket.

Cylinder block

An exceptionally rugged, durable cylinder block has been developed for this engine, providing adequate rigidity to support the loads. The loads are distributed evenly throughout the entire structure by five transverse bulkheads which tie the two blocks into a single rigid unit, made from a one-piece casting of high grade alloy iron. After various stress coat and strain gauge studies, as well as dynamic tests, it was not considered necessary to extend the casting below the centerline of the crankshaft.

Substantially larger water jackets have been provided around the full length cylinder walls than offered by any other competitive design, lowering the temperature of the working parts and giving unusually long life. The center-to-center distance of the cylinder bores is 5 in. and the over-all length of the block is 27.750 in. The upper half of the flywheel housing is cast integrally with the cylinder block, offering improved support for the transmission and propeller shaft by minimizing the deflection resulting from the attachment of these items.

Valve train

As a result of studies made during the development of the new engine, the cam profile was changed to decrease acceleration rates on both the opening and closing sides, and a lower rate valve spring was developed to reduce the cam nose loading. By using larger diameter, heavier wall tubing, the push rod rigidity was substantially increased, thereby minimizing deflection in the valve train. After making these changes, considerable improvement was obtained in the erratic behavior of the valve train formerly occurring at 4200 rpm. The critical lifter "pump-up" speed was increased to over 5000 rpm. The valve train now used in the new engine is shown by Fig. 6.

The precision molded alloy iron camshaft is hardened after casting, phosphate coated all over, mounted on five bearings, and chain driven. The cams are ground with a taper of 6 min, and are positioned 0.062 in. to the rear of the lifter centerline to avoid lifter over-run and insure positive lifter rotation.

The lifters are of the hydraulic type, having hardenable iron bodies. The lifter faces are ground to a spherical radius of 30 in., hardened to a minimum of 54 Rockwell C, and Lubrited for improved break-in.

As a result of extensive testing, valves were developed for this engine that possess life equivalent to the other components in the engine. The exhaust valve, for example, is of the special flexible head design to assure maximum conformability of the valve face and seat. Large valves in combination with the lift of 0.375 in. are important factors in the high performance of the new engine.

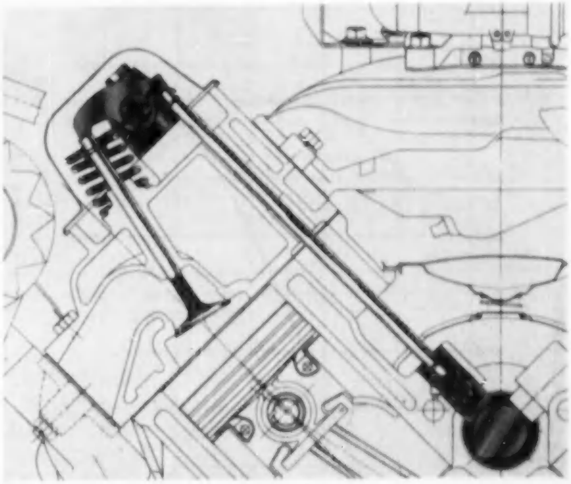


Fig. 6—Valve train of the Packard V-8. Lifters are of the hydraulic type, having hardenable iron bodies.

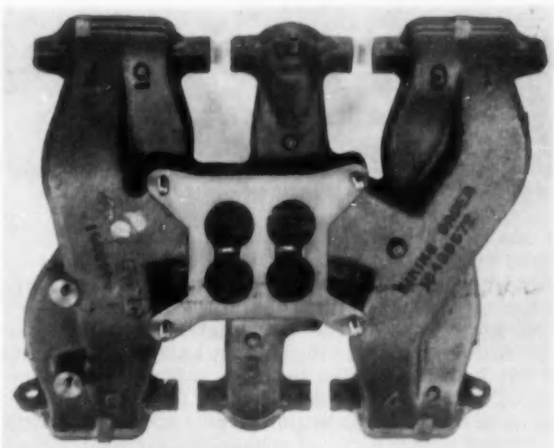


Fig. 7—Intake manifold has a 90 deg T-shaped configuration at the intersection of the branches.

Cored passages around the valve seats assure rapid and uniform heat dissipation to the coolant. Valve temperatures were further reduced by incorporating integral valve guides which eliminate the thermal barrier normally encountered with the separate valve guides. Stem-to-guide clearances were established at 0.001–0.002 in. for the inlet valves and 0.002–0.003 in. for the exhaust valves, requiring selective assembly in manufacture. Valve sticking results from deviation from the minimum limits, whereas inadequate oil control exists, particularly on the inlet valve, when the clearances are excessive.

Free-breathing induction system

Since the power output of the engine is so largely dependent upon volumetric efficiency, the induction system was designed to (1) obtain equal distribution

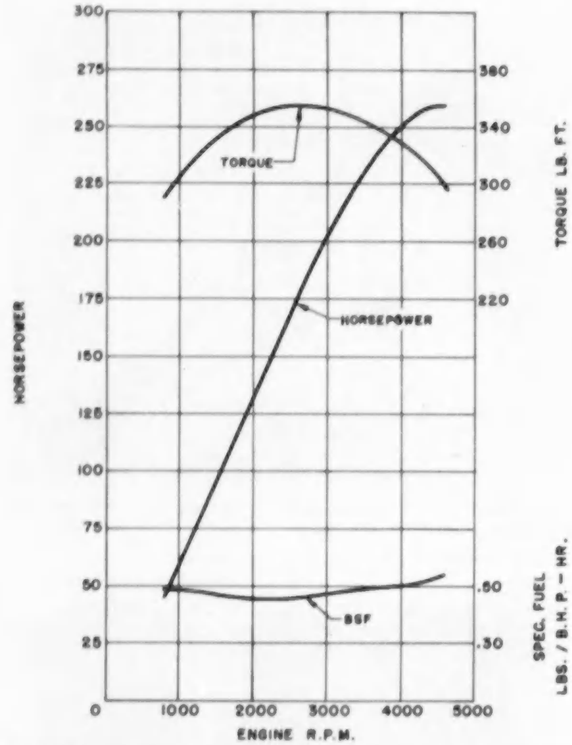


Fig. 8—Full throttle gross performance characteristics of the Packard V-8 equipped with a single 4-barrel carburetor.

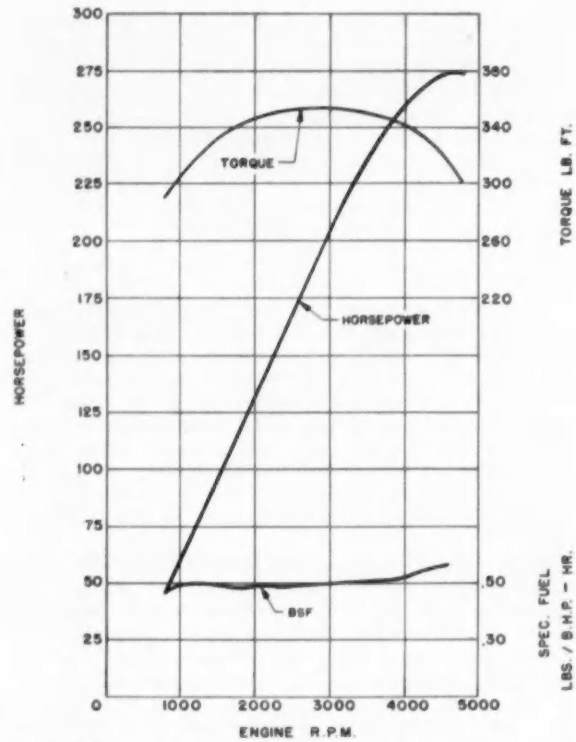


Fig. 9—Full throttle gross performance with dual 4-barrel carburetors.

of the air-fuel charge to all cylinders, (2) to minimize restriction, and (3) to promote turbulence only where desired for proper mixture of the charge entering the combustion chamber.

As illustrated by Fig. 7 the intake manifold has a 90 deg T-shaped configuration at the intersection of the branches. The passages are smoothly contoured and equal in cross-section area throughout. Generous radii are provided at all junctions. Cylinder head passages are similarly designed.

By taking advantage of the large bore offered by the new design, exceptionally large valves could be used, making an important contribution to the free-breathing characteristics of the engine.

Electrical system

A 12-v electrical system was adopted for the new engine because it offered the following benefits:

(1) Increased available voltage, providing an adequate reserve to fire the spark plugs under all driving conditions, and permitting greater gap growth before servicing is required;

(2) Higher generator output to meet the ever increasing loads, particularly at slow engine speeds; and

(3) Improved cranking motor performance to satisfy the cranking requirements under both cold and hot weather starting and operating conditions.

Performance

Fig. 8 shows the full throttle gross performance of the new Packard V-8 engine equipped with a single 4-barrel carburetor. The gross performance of the engine is based on the test results obtained with manual fuel and optimum spark, corrected to SAE standard conditions of 29.92 in. of Hg atmospheric pressure and 60 F air temperature.

The new V-8 develops 260 bhp and 355 lb-ft torque, whereas the L-head straight eight developed 212 bhp and 330 lb-ft torque. Although a substantial gain in horsepower has been obtained, the really significant achievement is the improvement in effective torque, which, after all, means the translation of engine output into actual car performance. For the new engine, the maximum specific output is 0.739 bhp/cu in. of displacement, and the maximum bmep is 152.1 psi at 2600 rpm. The friction horsepower has been reduced from 76 at 4000 rpm for the 1954 engine to 54 at the same speed for the 1955 engine, giving an improvement of 29%. The specific fuel consumption of the new engine is lower over the entire speed range, reaching a minimum of 0.452 lb/bhp-hr.

For still greater output, the new engine equipped with dual 4-barrel carburetors is available in the Packard Carribean models. This combination develops 275 bhp at 4800 rpm. (See Fig. 9.) The torque remains unchanged at a maximum of 355 lb-ft, although it is available over a broader speed range, namely, 2400 to 3200 rpm. Both engine friction and specific fuel consumption are slightly higher, however.

(Paper on which this abridgment is based is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Tips on Tools

J. R. Latus, Ladish Co.

Based on secretary's report of panel on Metal Cutting—New Angles on an Old Art, held as part of the SAE National Tractor Forum, Sept. 13, 1954.

Ultrasonic Machining

Vibrating a tool at 20,000–30,000 cps through a grit suspension against the work piece cuts the hardest materials. In fact, the harder the material, the easier the cut. Heat-treated steels, carbides, ceramics, glass, and germanium machine readily by this Cavitron process.

Grade 280 abrasive grit suspended in a fluid passes between the tool and the work piece. It transfers the impression of the tool end into or through the part. The tool may be of tool steel or a softer material. The work piece does not deform or change chemically.

The method can put 0.012-in.-diameter cross holes in ½-in. diameter carbide rods . . . bore 0.004-in.-diameter holes in 1/16-in. ceramic plates . . . and slice germanium to wafer thinness.

Ultrasonic machining is currently forming servo plunger parts and components of computers and typewriters, as well as other complicated parts formerly made in segments.

Drilling

To reduce drill breakage, a torque meter can be applied to the spindle and set up to actuate drill retraction when maximum allowable torque is reached.

The metal cutting experts serving on the panel which developed the information in the accompanying article were:

panel leader
F. S. Burnside, International Harvester Co.,

panel secretary
J. R. Latus, Ladish Co.,

E. L. Breese, Caterpillar Tractor Co.

G. Brown, Sheffield Corp.

P. L. Houser, International Harvester Co.

H. S. Hunter, John Deere Waterloo Tractor Works

W. L. Kennicott, Kennametal Co.

J. McDougall, Ford Motor Co.

Jack Touhy, Sheffield Corp.

Threading

High-speed thread rolls are finding wide acceptance. They actually cold forge the material and strengthen the thread itself. Threading with carbides is not so popular because of high initial cost and the care needed in handling to minimize breakage.

Milling, Hobbing, and Broaching

It pays to figure out how long cutters and broaches will last on particular jobs, then stop machines and change tools just short of this period. Tools are not excessively dulled. And work is not unduly interrupted.

Planing

Reciprocating attachments are available which make it possible to cut in both directions. Some new planers are built for reciprocating cuts.

Cold Forging

Cold forging is replacing machining as a method of shaping splines and gears. At least two forge makers market a parallel rack arrangement suitable for cold forming 3/32-in. standard 30-deg involute spines on 1⅛-in. diameter axle shafts.

Cold forming gives stronger teeth at lower cost per piece.

Cutting Lubricants

Detergent-base synthetic lubricants are replacing conventional oils for high-speed machining applications. The superior wetting action of the synthetics tends to dissipate heat and reduce machining stresses. Main objection to detergent-type lubricants is their tendency to attack the machine lubricant. This can be overcome by forced machine lubrication.

For the machining of hard bronze and similar nonferrous alloys, beeswax and kerosene lubrication products a good finish, with satisfactory tool life. But here again, the cutting fluid tends to wash away the machine lubricant.

(The report on which this article is based is available in full in multilith form together with reports of six other panel sessions of the 1954 SAE National Tractor Production Forum. This publication, SP-308, is available from SAE Special Publications Department. Price: $1.50 to members, $3.00 to nonmembers.)

At the SAE Summer

New Designs Seek New Materials

THE FUTURE of automotive design depends upon the development of high performance materials. As one engineer attending the SAE Golden Anniversary Summer Meeting said, "There's no limit to the inventiveness of the design engineer except the tools and materials he must work with."

Giving his imagination free scope, as an artist does, the automotive engineer theoretically can solve any of the problems he is now facing. However, in the automotive field, as in other fast-growing industries, materials and methods sometimes have lagged behind design.

One is reminded of the early days when repeated challenges channeled engineering effort into searching for longer-lived tires, stronger body materials, and more powerful fuels. Because of this work, materials soon approached the point where they were performing adequately in existing designs. Now, again, design is asking metallurgists, chemists, and physicists to provide materials with the strength, heat resistance, and machinability that will allow new dreams to be realized.

An outstanding example is the problem facing the designers of supersonic aircraft. High altitude, high speed flight (around Mach 4) is limited by materials which cannot stand the high temperatures encountered at those speeds.

At the Summer Meeting was detailed work that is attempting to develop stronger materials. One "hope" of the aircraft industry has been titanium. But it has not yet been able to fulfill the over-optimistic hopes that caught the fancy of an uninitiated public. Present costs—\$15 to \$35 per finished pound—limit it to government use where price is not important. The high price is not caused by scarcity since production of titanium sponge (which has no practical use in raw state) is about 20 times the amount being converted to useable alloy. But refining to pure useable metal is expensive. One difficulty is that molten titanium sucks up oxygen and other gases like a sponge and will eat up almost any refractory or crucible it is melted in.

A method of melting and casting titanium was described that looks promising. Melting it in a vacuum keeps it from reacting with the air, thereby getting a cleaner alloy. This method was heretofore used in laboratories on a small scale. Now however, it has been "scaled up" so that clean, high temperature alloys are becoming available in production quantities.

Search for Fuels

To meet the stringent demands of supersonic aircraft, new fuels are also being sought. In supersonic jet aircraft, fuel often is used as a heat sink, carrying off heat from the engine lubricating oil and other sources. Up to now the effectiveness of the fuel for this purpose has been limited by the instability of fuel at high temperatures. Gum and sediment are formed which tend to clog the fuel lines.

A new hydrocracking refining process produces fuel with stability for relatively long periods at temperatures between 400 and 500 F. And adding chemical dispersants and oxidation inhibitors will give fuels even more stability, both during storage and during use.

Search For Steel

On the ground, a major problem in the automobile industry is combatting weather corrosion of body steels. A new test has been developed that may point the way to retarding corrosion and prolonging the life of steels. The "cyclic humidity accelerated corrosion test" already has indicated that two types of rust attack body steels.

The first develops on car exteriors where paint is chipped and it causes the familiar orange rust which forms a protective coating and retards further corrosion.

The second type of rust occurs in hidden inaccessible places from which moisture cannot escape. This non-protective rust eats into the metal, eventually causing failure.

Of course, one of the best places to reduce corrosion is where it starts: in the steel itself. So, research is directing its efforts towards finding low cost alloy additives or a combination of elements in steel that will increase the resistance to non-protective rust.

Despite its several limitations, steel is still the choice of most engineers for the basic auto body material. There has been much experimental work using light metals or reinforced plastic to keep body weights down, offsetting the weight increases caused by the new automatic power accessories.

Search For Aluminum

The strength/weight ratio of aluminum looks promising, some discussers indicated. Aluminum also resists corrosion, has good thermal and heat conductivity, and is comparatively abundant now. More and more use of aluminum in the modern automobile is anticipated. Brake drums of aluminum (already standard equipment on many European sports cars) seem likely. Aluminum radiator grills, bumpers, and hub caps are also possibilities. In the far future aluminum cylinder blocks and radiators are thought possible *if* costs can be lowered sufficiently.

Search for Plastics

In their search for new materials, design engineers have also been investigating fiber glass reinforced plastic. It has many at-

CONTINUED ON PAGE 74

Meeting

The Society Enjoys Its Fiftieth Birthday

A PARTY ATMOSPHERE helped make the Golden Anniversary Summer Meeting at Atlantic City, June 12 through 17, one of the most successful ever for nearly 1500 SAE members, wives, and guests.

Social activities provided a busy schedule for members' wives, and complemented technical session interest for the engineers themselves.

A Golf Tournament, for men and women, at the Seaview Country Club, Absecon, N. J., was even more popular this year than last.

Highpoint of the evening activities was the dinner dance and birthday party on Wednesday evening in the Chalfonte Hotel. With the room studded by members wearing white dinner jackets, ladies in summer formal gowns, and decorations of flowers and palm trees, the atmosphere was as gala and light as the spirits of the 17 Pioneer members, who were the honored guests. SAE President Rosen welcomed the Pioneers and the other SAE members and their guests, and all the ladies present were given corsages of yellow roses upon arriving.

A five-tier birthday cake—one layer for each of SAE's decades—was wheeled in by two young ladies dressed in symbolic golden dresses, followed by waitresses with trays of ice cream topped by flaming sparklers.

President Rosen cut the first slice from the cake and the orchestra played the SAE Golden Anniversary March, which was composed by Macy O. Teetor.

On Friday, June 17, the five-day meeting was officially over. SAE members returned home, many thinking nostalgically of the past five days, many thinking of the past 50 years, and all looking forward to the next 50 years.

HAPPY BIRTHDAY TO SAE is sung by President and Mrs. C. G. A. Rosen along with 400 other guests at the dinner dance. Long table (below), stretching the length of the banquet room accommodated the pioneer members who joined the SAE during the years 1905-1910. Honored as one of the 17 pioneer members present (see page 72) B. B. Bachman (below right) accepts his plaque while Mrs. A. R. Miller smiles approval.

SAE's Pioneer Members Attend

SEVENTEEN of the Society's 44 living Pioneer members—those who joined before the end of 1910—attended the Summer Meeting and were honored guests at the fiftieth birthday dinner-dance and at President and Mrs. Rosen's reception preceding it.

As each Pioneer arrived at the meeting, Judy McCormick, who has been on the SAE staff since 1910, greeted him with a special pin of the design reproduced at the left above and an identifying gold ribbon badge.

Then at the dinner-dance Pioneers received plaques commemorating their long association with SAE.

These plaques were similar to the one presented to Pioneer P. M. Heldt at the SAE Golden Anniversary Annual Meeting in Detroit in January. (It was Heldt's editorial in "Horseless Age" that inspired formation of the Society.)

Throughout the week, Pioneers renewed old friendships. Several were able to find themselves in a group photograph which Alfred J. Poole had saved from an SAE Summer Meeting held 40-some

Above:
E. W. Weaver and Erik H. Delling
Left above:
William E. Haupt, Stephen Jencick, and Albert R. Miller
Left below:
Mrs. Vincent and her husband, Col. J. G. Vincent
Below:
Arthur J. Scaife and Mrs. Scaife

years ago at Cape May. And all had stories to swap about the early years of the Society and the industry.

With the new memories added to old, the Pioneers left toward the end of the week—some by train, some by airline, Frederick Moskovics in his new Mercedes-Benz, and Col. and Mrs. J. G. Vincent with Mr. and Mrs. George Holley in the Holley plane.

LEADING THE PARADE to the head table at the dinner-dance is Pioneer Member John G. Perrin, who has been an SAE member longer than any other living man. He is followed by Mrs. Perrin and SAE President Rosen.

Above:
George M. Holley and T. P. Chase
Right above:
Mrs. Winchester, William P. Kennedy, and J. F. Winchester
Right below:
Frederick W. Moskovics in the Mercedes-Benz he drove to the meeting
Below:
P. M. Heldt, George P. Dorris, and Alfred J. Poole

At the SAE Summer Meeting—Continued

tributes: (1) It resists corrosion and bending, (2) It is lighter than steel, (3) It makes possible construction that is impractical with sheet steel, (4) Tooling costs are lower, therefore greater styling flexibility is possible, (5) Service repairs and part replacement is relatively simple, (6) Safety is increased by way of improved impact absorption and better dissipation of crash energies.

On the other hand, all-plastic car bodies have several disadvantages: (1) it is difficult to mold fiber glass reinforced plastic parts with sharp corners that don't break down during use. (2) Bonding metal pieces to plastic presents difficulties. (3) Since plastic is a non-conductor, the body structure can no longer be used as an electrical ground; therefore the electrical system must be two wire.

So, while plastics and the new light metals have many current uses in automobiles, and the future will undoubtedly see more and more, design engineers are still seeking new body materials, or improved applications of old materials, for their new designs.

Search for Rubber

The automotive industry is also looking for new rubber or rubber-substitute materials for use in ground vehicle tires.

High speeds are creating a new set of requirements for passenger car performance. At the speeds that prevail today the tires now being produced perform quite well. However, at slightly higher speeds—about 100 mph—a standard tire will fail in about 50 miles of running. So, we are currently operating close to the limit of safety. The high speeds build up heat which deteriorates the strength of the rubber and cord materials. Although it is possible to improve the tread-to-carcass bonds and the tear resistance of the rubber stock slightly, there is not currently any improvement possible that will push up appreciably the speed at which failure will occur. The future will require new materials, many believe, no matter what the cost, so that high speed cars now being designed will ride on fully adequate tires.

Search for Greases

Automobiles that are being designed to go faster are affecting the lubricant field, too. Many years ago a chassis lubricant that was good for several hundred miles was considered adequate for the job. But, now, in cars capable of traveling well over 500 miles a day, with these old-time greases, it would be necessary to grease a car once a day. This, obviously is impractical. One session was told of some experimental greases which, although not as good as a suspension lubricant should be, seem to perform satisfactorily in dry weather for 800 to 1000 miles. With some further development lubricants may be compounded so they could give good results for at least 2500 miles. Even this is barely adequate, in the opinion of some engineers who believe development of higher performing chassis lubricants is the next, somewhat overdue, step.

Although the emphasis at the SAE Summer Meeting was for the most part on the search for new and better materials, one much talked-about event was a paper on the new M-combustion system of the MAN diesel engine, by Dr. J. S. Meurer.

The Whisper Engine

This engine—called the *Whisper* engine because of its smooth, knock-free combustion — uses a a rather revolutionary type of combustion concept. As the piston approaches the top center on the compression stroke a vigorous air swirl sweeps the piston cavity. Two jets of fuel penetrate into this and they form a little cloud before they strike the hot surface of the piston. In the meanwhile the balance of the fuel is smeared on the semi-spherical combustion chamber wall and becomes vaporized at a controlled rate. As the fuel is vaporized it ignites and burns in a narrow layer near the wall, then more fuel strikes the wall and the burning continues. The flame front never has a chance to advance and no large amount of fuel ever has a chance to crack at any one time. A more complete description of the MAN engine, as given by Dr. Meurer, and an account of the comments made by Sir Harry Ricardo, Dr. P. H. Schweitzer, Professor of Engineering at The Pennsylvania State University, C. G. A. Rosen, and other discussors, will be published in a coming issue of the SAE JOURNAL.

Highlights from this and other papers presented at the SAE Summer Meeting, in Atlantic City, follow:

ENGINE EFFICIENCY—In 1954, American motorists burned 44 billion gallons of gasoline which cost them close to 13 billion dollars. An improvement in economy of only 10% would mean a saving of 1.3 billion dollars each year. Mechanical efficiency, volumetric efficiency, carburetion, spark advance, and compression ratio are the main factors contributing to overall engine efficiency — **D. F. Caris, B. J. Mitchell, A. D. McDuffie, and F. A. Wyczalek, Research Laboratories Division, GMC,** "Mechanical Octanes for Higher Efficiency"

TITANIUM CASTINGS—Titanium has been highly touted, however it finds difficulty living up to its advanced billing. Probably it will be ten years before it is used in mass production — **M. E. Nevins, Wisconsin Centrifugal Foundry, Inc.,** "The Centrifugal Casting of Titanium Alloys"

ALUMINUM USES—Aluminum uses for the automotive industry will continue to increase rapidly. The brake drum and radiator of the future may be aluminum if costs can be lowered. Already radiator grills and other bright finish on passenger cars are being made of aluminum — **L. F. Swoboda, Kaiser Aluminum and Chemical Sales, Inc.,** "Future Aluminum Applications in the Automotive Industry"

VACUUM METALLIZING — Vacuum metallizing is now being used in the automotive industry for coating bright work, and fabrics and interior trim. It costs less than ½ the silver reduction process and less than ¼ the cost of electroplating — **J. G. Seiter, F. J. Stokes Machine Co.,** "Automotive Applications of the Vacuum Metallizing Process"

VACUUM MELTING—Melting alloys under a high vacuum keeps them from reacting with the air, thereby giving "clean" metals. Previously it was a laboratory process, but now it is scaled up for production — **H. Hamjian, Utica Drop Forge and Tool Corp.,** "The Vacuum Melting of High Temperature Alloys"

HEAT SINKS—In principle, the use of the fuel as a coolant appears to be a convenient solution to the problem of heat rejection. But in recent higher

CONTINUED ON PAGE 77

SIR HARRY RICARDO . . .

. . . receives the Horning Award from SAE President C. G. A. Rosen, chairman of the Award Committee. Reminisces in Memorial Lecture.

INTRODUCED as "Mr. Internal-Combustion Engine," Sir Harry Ricardo, distinguished British engineer, received the 1953 Horning Memorial Award June 13, 1955.

Presentation was made at a session of the SAE Golden Anniversary Summer Meeting sponsored by the Society's Fuels and Lubricants Activity which opened with SAE's F&L Vice-President J. F. Kunc Jr. in the chair. F&L Vice-Chairman for Meetings Leonard Raymond introduced SAE President C. G. A. Rosen, chairman of the 1953 Horning Memorial Award Committee.

"Sir Harry can look upon the development of the internal-combustion engine," Rosen said, "and truthfully say: 'All of this I saw and much of this I was.' "

On hand to extend personal felicitations to Sir Harry was Mrs. Harry Horning, on whose behalf President Rosen made the presentation.

The Award went to Sir Harry "in recognition of distinguished active service during his many years in the field of mutual adaptation of fuels and engines."

Sir Harry's Lecture will appear in full in 1955 SAE Transactions.

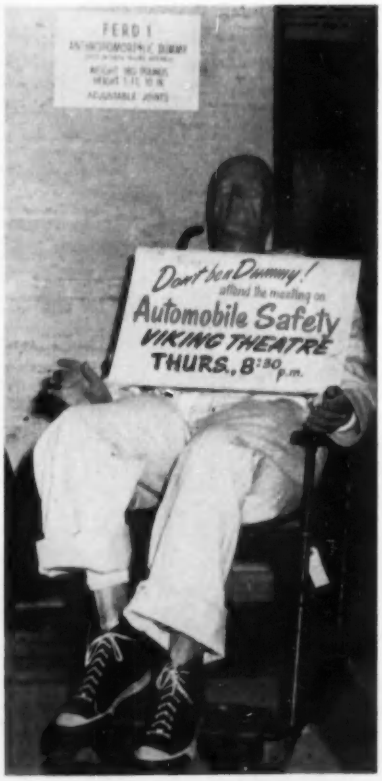
MRS. HARRY HORNING sits with Sir Harry Ricardo and President Rosen just prior to presentation of the Horning Award

PEOPLE . . .
At the SAE Summer Meeting

ON THE BOARDWALK, Professor L. C. Lichty of Yale University and Professor W. E. Meyer of The Pennsylvania State University enjoy ocean breezes while talking about technical subjects.

INSPECTING the Packard Torsion Level Suspension system, E. A. Ryder (left) listens to J. F. Kunc. Many of the technical papers presented during the five-day meeting were illustrated by mock-ups, models, and other displays.

STOPPING TO CHAT before attending a technical session, Vincent Ayres (left) passes the time with L. L. Bower. (Picture below) R. R. Chrisman (left) visits with A. F. Lucadamo and W. C. Eichelberger.



. . . AND DUMMY

speed aircraft, temperatures have actually been high enough to cause degradation of the fuel and the formation of insoluble sediment which clogs fuel systems — **A. B. Crampton, W. W. Gleason, and E. R. Wieland, Esso Research and Engineering Co.**, "Thermal Stability—A New Frontier for Jet Fuels"

FUEL STABILITY TEST—Thermal instability of jet fuels is related to the presence of trace amounts of reactive constituents. The hydrocarbons which make up the bulk of the fuel were found to possess excellent thermal stability in a series of tests in the Erdco Jet Fuel Coker — **D. P. Heath, C. W. Hoffman, and J. H. Reynolds, Socony Mobil Oil Co., Laboratories**, "Stability To Burn"

HIGH TEMPERATURE STABILITY—Many JP-4 fuels are not stable at the high temperatures encountered during high speed flight. This results in insoluble deposits which clog fuel lines. However, chemical additives will reduce the deposition tendencies of fuels . . . . . . **C. M. Barringer, E. I. du Pont de Nemours & Co., Inc.** "Stability of Jet Fuels at High Temperatures"

STORAGE STABILITY—The storage stability of jet fuels is a function of their composition. Straight run, catalytically cracked, and thermally cracked store best in that order. Storage stability can be improved by acid treatment, hydrogenation, and by restricting the access of oxygen from the air . . .
. . . **A. C. Nixon, C. A. Cole, and H. B. Minor, Shell Development Co.**, "The Effect of Composition and Storage on Laboratory Properties of Jet Fuels"

CONTINUOUS SAFETY—There's no such thing as absolute safety. When we talk about safety we're talking about a degree of safety.

In terms of fatalities per passenger-mile, the scheduled airlines were 29 times safer last year than they were nine years ago. But we'll never stop trying to make air travel still safer — **H. E. Gray, Pan American World Airways, Inc.**, "Safety and Reliability"

MAINTENANCE MOVES AHEAD—The art of predicting maintenance needs is being aided by linear programming and other operations research techniques.

But the real saving in maintenance delays will come when designers know as much about how to design a simple bracket as they already know about propeller blade design — **Marvin Whitlock, American Airlines, Inc.**, "Maintenance"

Distinguished Visitor Brings Greetings to SAE from British IME

BRIAN G. ROBBINS (left) brought to SAE at its Golden Anniversary Summer Meeting official greetings from the Institution of Mechanical Engineers, of which he is Secretary.

JOHN A. C. WARNER, SAE's Secretary and General Manager, (right) responded by expressing SAE's deep appreciation of the cordial and effective relationships which have existed between the two organizations since SAE's founding.

Presenting SAE with a parchment which places on record the IME's good feelings and hopes for SAE, Robbins noted that he brought greetings to SAE from both the Council of the Institution of Mechanical Engineers and from the Council of the Institution's Automobile Division. The parchment bears the signatures of IME President Percy L. Jones, of John Pitchford, chairman of the IME's Automobile Division, and that of Brian Robbins. (See p. 85)

Automobile engineers in the United States, Robbins said, have "demonstrated that quantity production is possible and economic." Speaking to his SAE audience, he continued:

"You were quick to tackle and solve the problems that arose in the machine shop, and you drew up standard specifications for size, method, and quality. Many SAE standards are now acknowledged throughout the world. You can justly be proud of your activities of the last 50 years—told so humanly in 'The SAE Story.' "

Responding to Brian Robbins' felicitations, John Warner said in part:

"We are highly honored to receive cordial greetings from the officers and members of the Institution of Mechanical Engineers. We are doubly pleased to accept those greetings from you, Brian Robbins, who have journeyed so far to present them.

"Unusual satisfaction comes to SAE at age 50 with the realization that you, Mr. Robbins, speak for a relatively venerable organization whose background of truly dedicated service extends over a period of 108 years. We are impressed by the lofty professional standards which have earned for the Institution and its 43,000 members a status of world renown.

"Our leaders would have me request that you take back to your eminent president, Mr. Percy L. Jones, and to Mr. John H. Pitchford, chairman of your Automobile Division, and to your Council and membership, a sincere and enthusiastic reflection of our deep gratitude for their kindly greetings."

The exchange of secretarial greetings took place just preceding presentation of the Horning Memorial Lecture by Sir Harry Ricardo on Monday, July 13, at the session sponsored by the SAE Fuels and Lubricants Activity.

Warner presented Robbins with the latest model portable transistor radio, telling him:

"This little gadget is adjusted to handle almost any language. When it performs to suit your taste and understanding, please think of us and remember that our affectionate thoughts and best wishes are traveling along with you, whether on Atlantic City's boardwalk or at your own headquarters, Number 1, Birdcage Walk."

PLEASANT HOURS of card playing in the Solarium were arranged by Mrs. P. H. Oberreutter (top, left) and Mrs. E. M. Schultheis, chairman and co-chairman respectively of ladies' bridge and canasta. Ladies entering the Chalfonte's Carolina Room (center) for the dinner-dance received corsages of yellow roses. Throughout the week dancing (bottom) was a popular evening diversion.

At the SAE Summer Meeting—Continued

ALWAYS SOMETHING NEW—A pilot's training is never finished. We're always giving him a new gadget to work with. Next big wave of new devices for pilots to learn to handle will come when we start flying turboprop and turbojet transports at 40,000 ft — **C. R. Springer, Trans World Airlines, Inc.**, "Operations"

SERVICE SELLS AIR TRAVEL—Passengers notice the little things. The airliner may be of the most modern design, expertly piloted, and carefully maintained. All these things the passenger takes for granted. But if the stewardess serves lukewarm coffee or the baggage handlers mar a suitcase, we may send the customer to the competition. We mustn't lose sight of the details of the business — **D. F. Magarrell, United Air Lines, Inc.**, "Passenger Service"

RUST PROBLEMS—Corrosion failure of auto bodies is generally the result of non-protective rust formation. Non-protective rusts, produced in sheltered areas of the car body, are composed of large amounts (80 to 90%) of magnetite and small amounts (10 to 20%) of Fe_2O_3 hydrates. Alloys which aid protective rust formation outdoors do not necessarily contribute to protective rust formation under conditions of sheltered corrosion — **J. C. Holzwarth, R. F. Thomson, and A. L. Boegehold, Research Laboratories Division, GMC**, "A Study of Non-Protective Rust Formation on Auto-Body Sheet Steel"

PROTECTIVE COATINGS—Temperature is a most important consideration when applying protective coatings to low alloy steel. Where cadmium plate can't be used because of temperature limitations, an aluminum pigmented silicone resin would probably be used, unless resistance to abrasion is considered critical. Then diffused nickel-cadmium plate would be specified. Electroless nickel plate resists corrosion and abrasion, but because of its adverse effect on fatigue strength it is used only on relatively low stressed parts — **H. J. Noble and W. H. Sharp, Pratt & Whitney Aircraft, Division of United Aircraft Corp.**, "Steels and Protective Treatments For Use Up to 1000 F"

COMPUTER THINKING—The use of computers, both analog and digital, compels engineers to do more thinking rather than less: the stress is on thinking about the actual physics or dynamics of the design being worked on. The engineer must be able to answer questions about accuracy requirements, ranges of variables, number of solutions desired, what variables are to be plotted, and characteristics of non-linear elements, to mention just a few. He must understand the whole problem thoroughly himself before he can expect a machine to do so — **R. A. Roggenbuck and R. D. Jeska, Ford Motor Co.**, "Analog and Digital Computer Methods for Engineering Problems"

ISOTOPE FUTURE—Future uses of isotopes will probably include (1) replacing x-ray units where economy and portability are important, (2) tracing quantities of material in mixtures, (3) following tagged materials through industrial processes, (4) locating hidden machinery parts . . .
. . . **A. M. Smith, Ford Motor Co.**, "Radioactivity and Automotive Measurements"

STRESS ANALYSIS—Brittle lacquer, bonded wire resistance strain gages, and to a certain extent, photoelasticity have both simplified and complicated the experimental determination of strain. The strain gages have made possible reasonably accurate measurements in regions where a mechanical device would be difficult. Complications arise from the electronic and optical instruments necessary for the more involved problems solved by electric strain gages or photoelasticity — **Ned Fuller, Jr., and R. H. Stimpson, Engineering Research Department, Ford Motor Co.**, "Experimental Techniques in the Stress Analysis of Automotive Components"

VALVE BURNING—Most combustion chamber deposits become markedly corrosive to metals at temperatures approaching their melting points. Under normal operating conditions, with valves that are seating properly, valve face temperatures are sufficiently below the melting points of the deposits and corrosion proceeds slowly. When dynamic sticking occurs, the cooling of the valve by seat contact is affected and valve temperature increases, highly accelerating corrosion of the valve face — **W. D. Sims, Shell Oil Co.**, "Instrumentation for Valve Burning Studies"

CHAMBER VOLUME—Sonic and pneumatic instrumentation has provided highly accurate and efficient solutions to the special problems of measuring combustion chamber volume. The pneumatic method is espe-

GOLF CHAMP Frank Farrell receives trophy from A. L. Pomeroy (top). Pomeroy was chairman of the men's golf tournament, and Mrs. Pomeroy (center) was chairman of the ladies' golf tournament. Winner of the ladies' event was Mrs. James Kyle (bottom) who received a silver tray as award.

cially adapted to measuring deposits since the "wetting" and flotation problems of liquid measurement are eliminated and the damping problem of the sonic method is avoided — **G. A. Weinert, Ford Motor Co.**, "Pneumatic and Sonic Measurement of Combustion Chamber Volume"

HEAVY DIESEL FUELS—If you're not careful, you can be penny-wise and pound-foolish in using heavy diesel fuels. True, they cost less per gallon. But: (1) You have to heat heavy fuels to about the same viscosity as that of the usual lighter diesel fuels to get good distribution within the combustion chamber. (2) You have to clean up the heavy fuel before you inject it, which adds to its cost. (3) Parts wear faster in engines operated on heavy fuels — Round Table on How to Burn Heavy Diesel Fuels, **M. J. Anderson, Ethyl Corp., leader**

SPECIFICATION POLICY—One major passenger car maker believes in allowing some leeway in steel call-outs so that the shop can make a slight change without bothering to secure permission to deviate from the engineering department. Two other car makers are tightening their call-outs. They feel that, especially with automation, there's one best material to use—and they want to be sure to use that one — Round Table on Material and Process Specifications Systems, **Muir Frey, Allis-Chalmers Mfg. Co., leader**

MANUFACTURING RESEARCH PAYS—Continuous surface broaches, developed by a maker of jet engine blades and a machine tool builder, save money at least four ways: (1) One continuous broach does the work of four or five conventional vertical broaches—and costs less. (2) The continuous broach takes up less floor space. (3) Women operators tend the continuous broaches, replacing the higher-paid male vertical broach operators. (4) The continuous broach uses carbide tools, which have a much longer life than their steel counterparts used with the vertical broach — Round Table on Manufacturing Research Programs Pay Dividends, **K. W. Stalker, General Electric Co., leader**

NEW DIESEL THEORY—Diesel knock can virtually be eliminated even at very low speeds, resulting in a quiet engine with extremely elastic torque characteristics if the MAN combustion system is used. In the M-system, only a small portion of the fuel is allowed to undergo diesel-type autoignition, while the combustion of the greater part of the fuel charge has the reaction characteristics of that in the gasoline engine. Engines with the M-system can be operated as true multi-fuel engines without sacrificing performance — **J. S. Meurer, Maschinenfabrik Augsburg Nurnberg (MAN)**, "Evaluation of Reaction Kinetics Eliminates Diesel Knock—The M-Combustion System of MAN"

DYNAMIC ANALYSIS—When a ride analyst looks at a car he sees a problem in dynamics, and thinks of the car as a collection of springs, masses, and dampers. To determine the ride characteristics the ride analyst must study the motions of the system and the interaction of the various components. The ride data must be interpreted in terms of the passenger's motion response. To do this, the passenger's body must be considered as part of the system — **A. C. Bodeau, R. H. Bollinger, and L. Lipkin, Ford Motor Co.**, "Passenger Car Suspension Analysis"

TORSION LEVEL SUSPENSION—The new Packard Torsion Level Suspension consists of two features: (1) Long torsion bars connecting the front and rear wheels by suitable linkage that cause the car to ride level when passing over bumps and holes. These bars are also responsible for the "soft" ride. (2) Short torsion bars connecting the rear wheels to the frame. Also, an adjusting mechanism that keeps the car level at all times, whether it is empty or has six passengers and over 300 lb of baggage — **F. R. McFarland, Studebaker-Packard Corp.**, "The New Packard Torsion Level Suspension"

1000-MILE GREASES—We are at present trying some experimental greases which, although not yet as good as a suspension lubricant should be, seem to perform satisfactorily in dry weather for 800 to 1000 miles — **L. J. Kehoe, Jr., General Motors Corp.**, "A Critical Look at Chassis Lubricants"

GREASE RETENTION—The higher the base oil viscosity, the better the grease will stay in the suspension joints. For the greases with heavier base oil, there is considerable increase in friction as temperature decreases. Also, steering effort increases excessively when heavy base oil greases are subjected to low temperatures — **J. B. Beltz, Oldsmobile Division, GMC**, "Chassis Grease Retention Tests"

At the SAE Summer Meeting—Continued

CENTRALIZED LUBRICATION—Up to now centralized lubrication has been too expensive for passenger cars. However the development of ball joint suspension and a new type of nylon tubing has changed the picture. One pumping unit is all that is necessary with ball joint suspension, and nylon tubing provides low cost, durable, flexible connections — **C. H. Mueller, Lincoln Engineering Co.**, "Centralized Chassis Lubrication"

RHEOPECTIC GREASE—A new rheopectic grease for use in automatic lubricators has the consistency of an oil. However, once fed through the lubricator it thickens to grease consistency, thereby providing a lubricant with the good qualities of both oil and grease — **J. D. Neesley, L. C. Brunstrum, and H. J. Liehe, Standard Oil Co. (Indiana)**, "A Rheopectic Grease For Chassis Lubrication"

WATER VERSUS GREASE—Water contamination of grease-lubricated chassis parts reduces the effective life of the lubricant and promotes corrosive wear. Water corrosion of wheel bearings also occurs particularly during non-operating periods and may lead to premature fatigue failure of bearing surfaces — **J. A. Bell, Shell Oil Co.**, "Corrosion Inhibited Automotive Greases"

MULTIPURPOSE GREASE—If a multipurpose grease approaches the performance of specialized lubricants for any particular fleet or service, its adoption is warranted, in most cases, because of the many direct and indirect savings in labor and product simplification. Different grades may be necessary to serve different operating conditions. Selection of automotive multipurpose grease should be based on service performance since laboratory tests are not reliable — **J. M. Stokely, California Research Corp.**, "Service Requirements for Multipurpose Automotive Greases"

GREASE CLASSIFICATION—Greases may be improperly classified in accordance with the metallic radicals of their soap components in such a way as to imply that all greases made with soaps having the same metallic radical, such as sodium, calcium, or lithium, have common performance levels. Actually, greases of the same type by that classification may vary widely in dispensability and performance properties, even though they contain the same mineral oils — **T. G. Roehner and E. L. Armstrong, Socony Mobil Laboratories**, "Common Denominators for Automotive Chassis Greases"

GREASE PERFORMANCE—A road test was conducted to obtain driver reaction to four chassis lubricants. Both chassis performance and squeaks heard by the driver were evaluated. Results indicate that a 1000-mile lubrication frequency is important since there was a large increase in complaints beyond 1250 miles of operation — **J. F. McGrogan, The Atlantic Refining Co Inc.**, "Chassis Lubricant Performance—Driver's Reaction"

NLGI IS RIGHT—The National Lubricating Grease Institute says you don't have to pack the wheel hub with grease —you just need to smear grease around the wheel bearing race. We were a little suspicious of this recommendation, so we checked it experimentally. Now we're sure NLGI is right. Our field tests showed that if you pack enough grease into the bearing, you don't need to pack the hub — **E. O. Forster and J. J. Kolfenbach, Esso Research and Engineering Co.**, "Fundamentals of Wheel Bearing Lubrication"

WHEEL BEARING GREASE—No lubrication job requires more skill than packing grease into wheel bearings. You have to make sure that the grease is not contaminated before it's applied. You have to clean out all the old grease —and blow the bearing dry with dust-free air. And you have to add the right amount of the right grease — **P. V. Toffoli, Jr., National Lubricating Grease Institute**, "Taking the Confusion Out of Wheel Bearing Lubrication"

LIGHT - STABLE PLASTICS — Light stability can be imparted to any type of polyester without necessarily involving a resin modification. It's done by adding to the polyester a chemical compound known to be an ultraviolet light absorber — **H. A. Hoppens, Barrett Division, Allied Chemical & Dye Corp.**, "Polyester Resin"

REINFORCING GLASS—Glass fibers have many of the characteristics of bulk glass. But some properties are severely modified. For example, fibers are stronger but less resistant to chemicals. Also, fibers are much more resilient — **C. E. Hoover and Ralph Sonneborn, Owens Corning Fiberglas Corp.**, "Glass Fiber Reinforcement"

PREMIXED MOLDING COMPOUND —In conventional die molding of plastics, resin and filler only are premixed. Then they are poured over the glass-fiber preform or mat. The closing of the heated matched dies forces the resin-filler mixture through the mass of fibers.

If you take the same ratio of glass, resin, and filler and mix them all together, you have a premix compound. It's cheaper, faster, and easier — **James Grieg, Woodall Industries**, "Matched Metal Die Molding of Premixed Reinforced Plastic Molding Compound"

GLASS IMPARTS STRENGTH—Mechanical properties, except compressive strength, of glass-fiber-reinforced plastic increases with glass content. That's because tensile loading is borne mainly by the glass. (However, in compression the glass acts merely as a void and the cured resin carries the load.) — **J. G. Coffin, Chevrolet Motor Division, GMC**, "Properties of Glass Fiber Reinforced Plastic"

WHY PLASTICS?—Fiber-reinforced plastic is dent-proof and rustproof. It saves weight. It damps sound. It's easy to repair or replace. And it may promote safety by virtue of its superior impact absorption and dissipation of crash energies — **Woldemar Schultz, Ford Motor Co.**, "Design Factors to be Considered"

DODGE USES PLASTIC DUCT—Heater ducts in 1953 Dodge cars equipped with power steering were made of plastic because contours were too severe for conventional KB board construction. This was Chrysler Corp.'s first production use of plastics. The part was essentially polyester resin, sisal fiber, and inert fillers. Performance was entirely satisfactory — **A. J. Carter, Chrysler Corp.**, "Reinforced Plastic Heater Housings and Ducts"

INTEGRATED BODY SECTIONS—With the preform type of glass-mat-reinforced plastic part, practically any body panel can be molded if back draft is avoided. Parts too complicated to be drawn in steel are easy to mold in plastic. So it's possible—and advisable —to break the body into only a few large molded parts when you're designing for plastics — **Carl Jakust, Chevrolet Motors Division, GMC**, "Application of Reinforced Plastic for Major Body Panels"

MOLDING PLASTICS—The best way to produce void-free parts in glass-fiber-reinforced plastic is to pressure mold them in matched metal dies. This process gives strong, smooth, accurate parts — **Robert Morrison, Molded Fiber Glass Body Co.**, "Matched Die Molding Using Fiber Glass Preforms or Mat"

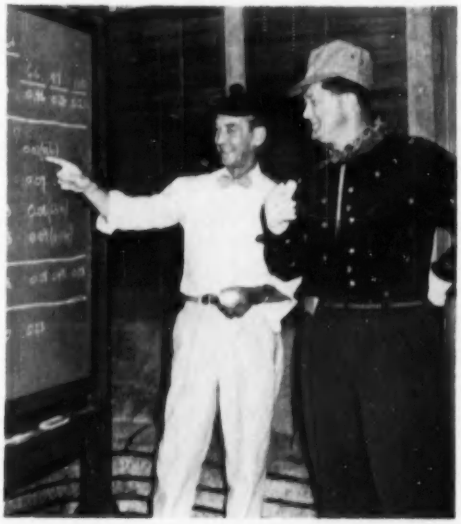
CONTINUED ON PAGE 82

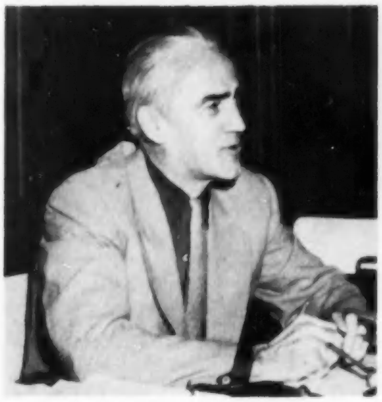
Visiting with Committees

Above:
SAE President Rosen sparked the Section officers' get-together sponsored by the SAE Sections Committee.

Right:
Chairman R. J. Pocock, bedecked in railroad engineer's gear, ran the Filter Test Method Subcommittee with the help of beret-wearing Recording Secretary S. L. Earle.

Below:
Left: Vice-Chairman A. O. Willey led the SAE Meetings Committee meeting, where selection of national meeting sites and technical paper quality received much consideration.
Center: Chairman E. S. Gallagher is pondering a technical question raised by a member of his SAE Aircraft Electrical Equipment Committee, A-2.
Right: Ground vehicle electrical problems also came in for serious discussion at the meeting of the SAE Electrical Equipment Committee led by A. D. Gilchrist.





SKEET . . .

. . . New young shooters vie with veterans. Tie for tops.

Veteran SAE skeet expert F. P. Zimmerli and W. W. Schafer, representative of the several younger participants in this popular Summer Meeting event, tied for top honors in the skeet contest held during the Golden Anniversary Summer Meeting. Site of the event was the Atlantic County Game Preserve at Estellville, N. J.

TIRE DESIGN—Tire design is always a compromise. If high speed characteristics are obtained by using low crown angles, stiff undertread constructions, or high inflation pressures, then ride comfort is sacrificed. If extremely flexible casings and lower pressures are used to increase deflection and comfort, they will give rise to directional instability at high speed — **T. J. P. Joy, D. C. Hartley, and D. M. Turner, The Avon India Rubber Company, Ltd.,** "Tires for High Performance Cars"

CORNERING FORCES—The ability to corner well and to maintain control easily are major factors in the overall performance of the car, and may contribute much to safety and pleasure. Cornering force seems to be an inherent characteristic of the pneumatic tire which will be difficult to change greatly by tire construction — **J. J. Robson, Firestone Tire and Rubber Co.,** "High Speed Cornering Forces"

HIGH SPEED TIRES—At a sustained speed of 100 mph, the standard passenger car tire at normal inflation and load will fail in about 50 miles. This same tire does not fail in continuous operation at 94 mph. This shows how close we are operating to the safety limit, and tomorrow we may be beyond it — **E. H. Wallace, and S. A. Lippman, United States Rubber Co.,** "Operation of Passenger Tires at High Speeds"

TIRE FINGERPRINTS—Evidence that cornering affects tire wear is contained in tire "fingerprints." A tire that wears rapidly has many ridges of fine sawtooth section over the tread surface. These are caused by the tire scraping on the ground as it slips during cornering. The line of the ridges is at all places perpendicular to the movement between the tire and the road — **V. E. Gough, Dunlop Rubber Co. Ltd.,** "Practical Tire Research"

COOLING SYSTEMS—The trend is toward using more aluminum in cooling systems. We already know how to make good aluminum condensers. The aluminum-brass radiator is probably about a year away, and the all-aluminum radiator is several years away.

Pressure caps cut down on deposits. That's because there's less water lost, less water added to make up for evaporation losses, and therefore less residue — Round Table on Cooling Systems, **Roger Birdsell, Yates-American Machine Co., leader**

DROP CENTER TIRE—The new drop center tubeless truck tire offers the following advantages: (1) puncture protection, (2) blowout resistance, (3) cooler running, (4) improved ride, (5) simplification, (6) weight savings. Some of these derive from the 15 deg taper drop center rim combination — **T. A. Robertson and R. P. Powers, The Firestone Tire & Rubber Co.,** "The New Drop Center Tubeless Truck Tire"

SKEET CHAIRMAN R. I. Potter (left) and about half the participants in the 1955 skeet shoot watch from the sidelines as Wayne Goodale (above) takes his turn at the traps. Fourth from the right is F. P. Zimmerli. Darl F. Caris (fourth from left) keeps score.

Ladies Describe . . .

. . . car parts; men guess in new Met Section stunt.

Each of 10 three-woman teams studied a different automobile part, picked one of their team as spokesman, and dared several hundred engineers to identify the part from the description she gave at Metropolitan Section's Sunday evening party . . . opening event of the Golden Anniversary Summer Meeting.

Prizes went to the three teams judged to have given the most effective descriptions of the part they had studied . . . and to the three men who turned out to have guessed right most often after listening to the descriptions.

Master of Ceremonies for the event was Merrill C. Horine, currently an SAE Councilor, while Sidney Tilden, Jr., credited with spark-plugging the novel stunt idea, was one of four judges, the others being Met Section Chairman R. M. Cherryholmes, R. W. Hogan, and R. M. Cokinda.

Lower picture: Master of Ceremonies Horine announces the winners of the parts identification contest while Judges Tilden and Hogan (seated, left to right) check the scores. Standing behind them is Judge Cokinda. Upper picture: Judge Cokinda presents the ladies of the winning team, who are (left to right): Mrs. E. E. Husted, Mrs. A. C. Kellermann (spokesman for the team), and Mrs. Wilbur W. Young.

TUBELESS TRUCK TIRES—When the tubeless feature is added to tires of conventional dimensions and design, the results are uniformly satisfactory. The principle of using a circular rubber gasket for sealing a rim or wheel for tubeless pneumatic tires is fundamentally sound, and a very practical way of doing the job — **C. R. Case, Goodyear Tire and Rubber Co.,** "A Universal Program for Tubeless Truck Tires"

DOCTORS BUY THUNDERBIRDS—Ford is now producing Thunderbirds at the rate of 600 per week. Biggest market is doctors.

About five times as many station wagons are sold now as in 1951. Builders attribute this to the rise in the number of children per family and the population drift to the suburbs — Round Table on Trends in Body Types, **K. E. Coppock, Fisher Body Division, GMC**

TWIN ULTRAMATIC DRIVE—The Twin Ultramatic, introduced in the 1955 Packard, Clipper, Hudson, and Nash lines, offers two distinct driving ranges to its owner. The 1.82 low range planetary gearing is automatically available whenever its use affords a greater vehicle accelerating rate. Also, the high gear converter performance that characterized the original Ultramatic is made available at the driver's option — **C. J. Lucia and J. Z. DeLorean, Studebaker-Packard Corp.,** "The Twin Ultramatic Transmission"

TURBO DRIVE TRANSMISSION—The 1955 Lincoln Turbo Drive Transmission is of the torque converter type with three-speed planetary gearbox. Its 2.4/1 low gear, plus a highly efficient torque converter with 2.1/1 stall torque ratio, provides adequate ratio coverage to permit use of a 3.07/1 axle ratio and still maintain excellent overall performance — **H. G. English, Ford Motor Co.,** "Lincoln Turbo Drive Transmission"

TWIN HYDRA-MATIC DRIVE—The GM Twin Hydra-Matic Transmission provides full power shifting, and automatic selection of the proper ratio for maximum performance. It is used with both gasoline and diesel engines in the 200-hp range and will handle 600 ft-lb of torque. A very large fluid coupling helps efficiency. The weight and size of the transmission do not exceed heavy-duty transmission combinations and clutch assemblies — **L. T. Flynn, and F. W. Brede, GMC Truck and**

At the SAE Summer Meeting—Continued

Coach Division, "GM Twin Hydra-Matic Transmission"

VARIABLE PITCH STATOR—By using a variable pitch stator vane in Buick's Dynaflow transmission it is possible to use the best vane angle for cruising and normal acceleration, and another vane angle for the best performance. The stator vanes are pivoted so that the driver can adjust the converter to meet his driving conditions — **R. J. Gorsky, Buick Motor Division, GMC**, "Buick's Variable Pitch"

FRICTION MATERIALS—In selecting friction material for automatic transmissions the following use factors must be considered: (1) frictional values necessary, (2) temperature of operation, (3) engagement characteristics required, (4) durability needed, (5) comformability, (6) release aids, (7) unit pressure on friction materials, (8) price — **J. F. Johnson, Raybestos-Manhattan, Inc.**, "Clutch Plate Friction Materials For Automatic Transmissions"

OIL-SOAKED LININGS—A superior lining for use on automatic transmission bands should have a relatively high coefficient of friction. Linings of comformable type, preferably with a discontinuous surface pattern, are believed to provide high frictional characteristics. The lining should resist frictional fade, must be durable, and must not deteriorate in hot transmission oil — **R. T. Halstead, and W. J. Eckert, Johns-Manville Corp.**, "Certain Aspects of Friction Materials and Their Performance in Automatic Transmission Oil"

TESTING FOR FRICTION—Usually friction test machines are of two types: (1) Constant speed-constant torque, or if desired, constant pressure-variable torque, (2) Deceleration unit using the inertia stop principle wherein a rotating flywheel is brought from a given speed to zero rpm. This is usually accomplished in several seconds or less depending upon the environment — **H. W. Schultz, Moraine Products Division, GMC**, "Experimental Testing of New Friction Materials for Automatic Transmissions"

WHY BRAKE LINING LIFE VARIES—When one brake lining wears faster than another, it's because it has suffered higher interface temperatures. These temperatures vary from vehicle to vehicle—and from brake to brake on the same vehicle—because of differences in: (1) drivers, (2) weight distribution, (3) brake torque and working drum area, (4) synchronization and rate of build-up, (5) maintenance and adjustment, and (6) terrain and service — Round Table on Brakes, **J. V. Bassett, Raybestos-Manhattan, Inc., leader**

SAE FORMULA CORRECTED—The factor for air resistance in the SAE Truck Ability Prediction Procedure is a little high. Originators of the formula now think the factor should be about 20% lower, and they intend to change the Procedure accordingly — Round Table on Power Train Compatibility, **J. F. Swift, International Harvester Co., leader**

ALUMINUM DIE CASTINGS—Chrysler's torque converter housings are the biggest structural aluminum die castings used in the automotive industry. Their biggest advantage is the weight saving. While a cast iron housing plus adaptor plate weighs 55½ lb, the aluminum assembly weighs only 17¾ lb — **F. R. Holliday, Chrysler Corp.**, "Chrysler's Die Cast Aluminum Torque Converter Housings"

HUMAN FACTORS IN SAFETY—Drivers should be indoctrinated in the effects of various temporary conditions upon their safety and efficiency. Alcohol has a deleterious effect upon driving skill even in relatively low concentrations. Emotional disturbances also make drivers more accident prone. Environmental variables such as temperature, humidity, ventilation, noise, and vibration also affect the comfort, health, and efficiency of the driver.—**R. A. McFarland, Harvard School of Public Health**, "Human and Environmental Factors of Automobile Safety."

AUTOMOTIVE SAFETY—Preliminary 1954 statistics indicate the traffic fatality rate has continued its downward trend. With a new figure of 6.4 deaths per 100 million miles of travel, a 60% reduction in the traffic toll has been achieved during the last 24 years. This is all the more remarkable when we consider that during the period from 1945 to 1952 vehicle registrations increased over 70% and the total miles of annual travel increased two-fold, while the available highway mileage increased less than 1% — **A. L. Haynes, Ford Motor Co.**, "Design Factors in Automotive Safety"

FLEET PROBLEMS—Selecting the correct vehicle for a given hydra-matic transmission is very important. We can't use a truck with a vastly overloaded transmission and get away with it. The transmission overheats and fails. In one instance failures were prevented by water-cooling the transmission. But manufacturers must continue to improve the design of the automatic transmissions — **G. H. Maxwell, Hertz Stations, Inc.**, "Effect of Hydramatic Transmissions on Gasoline Economy and Result in Maintenance Costs"

TRUCK AUTOMATIC DRIVES—The greatest savings in operating costs will be realized from the added engine life that is obtainable with the use of automatic transmissions. The elimination of human error that allows engines to be lugged by being in the wrong gear also helps save a great many wasted man-hours in our maintenance shops — **W. J. Crocket, Cooper-Jarrett, Inc.**, "Actual Operating Experience and Data of Automatic Transmission in Heavy Vehicles"

DRIVER REACTION—Our drivers are very high in their praise of operation of tractor trucks using Hydra-matic transmission on icy or wet roads. They are able to keep moving on slippery roads during winter months when tractors with mechanical shifts have to stop until road conditions improve. With automatic shifting through the seven stages of the transmission, they are able to maintain higher speeds on hills because vehicle momentum is not lost — **M. S. Hanna, Akers Motor Lines, Inc.**, "Actual Operating Experience of Automatic Transmissions"

NOISE REDUCTION—Many states and cities are enacting legislation to require fleet operators to suppress noise from vehicle exhausts. Twelve states have from one to three different laws on the books, most of which specify muffling devices above a certain decible volume. The N. Y. Omnibus Corp., which operates 1250 diesel coaches for over 265 million passengers a year is very conscious of the noise and fuel waste due to improper combustion. They use a premium fuel and a carefully scheduled maintenance program to do their bit — Round Table on Smog and Noise Reduction, **Emil Gohn, Atlantic Refining Co., leader**

SCROLL presented to SAE

By

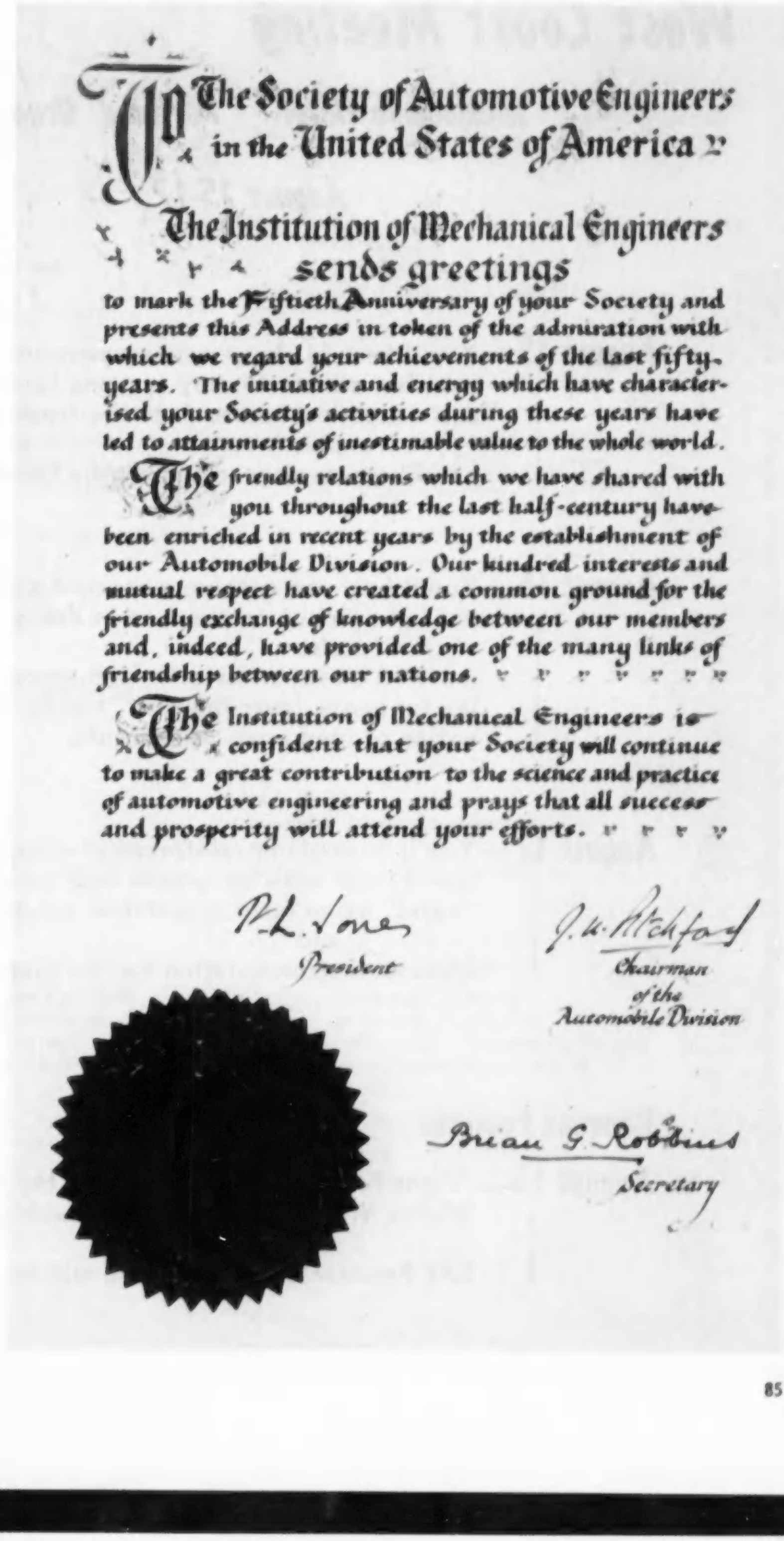
The Institution of Mechanical Engineers

on the occasion of

SAE's

Golden Anniversary

Summer Meeting


To The Society of Automotive Engineers in the United States of America

The Institution of Mechanical Engineers sends greetings to mark the Fiftieth Anniversary of your Society and presents this Address in token of the admiration with which we regard your achievements of the last fifty years. The initiative and energy which have characterised your Society's activities during these years have led to attainments of inestimable value to the whole world.

The friendly relations which we have shared with you throughout the last half-century have been enriched in recent years by the establishment of our Automobile Division. Our kindred interests and mutual respect have created a common ground for the friendly exchange of knowledge between our members and, indeed, have provided one of the many links of friendship between our nations.

The Institution of Mechanical Engineers is confident that your Society will continue to make a great contribution to the science and practice of automotive engineering and prays that all success and prosperity will attend your efforts.

P. L. Jones
President

J. H. Pitchford
Chairman of the Automobile Division

Brian G. Robbins
Secretary

The scroll was presented by IME Secretary Brian Robbins on June 13 in Atlantic City. (See p. 77)

1955

Golden Anniversary

West Coast Meeting

Multnomah Hotel Portland, Oregon

August 15-17

August 15 —You'll be told about new suspensions for commercial vehicles, air break-away systems for tractors and trailers, and a practical approach to the truck noise problem,
. . . plus . . .
panel reports on practical engine break-in methods.

August 16 —You'll hear the problems encountered with high-powered output light pickup trucks used in dense city traffic driving,
. . . also . . .
material on supercharging high-speed diesels, manifold braking for heavy "over the road" trucks, and "oil spot" evaluation of used engine lubricants.

August 17 —You'll learn about reinforced plastics development in commercial vehicles, plastic body repair, automotive use of "zytel" nylon resin, a practical stopping ability regulation,
. . . and . . .
ideas on instrumentation for the shop.

Banquet Features

August 16 —"Fight For Men's Minds" will be the topic of your speaker, Walter W. Belson, American Trucking Associations, Inc.,
. . . also . . .
SAE President C. G. A. Rosen will have a message for you.

1955 SAE GOLDEN ANNIVERSARY NATIONAL MEETINGS . . .

August 15-17
West Coast Meeting
Hotel Multnomah, Portland, Ore.

September 12-15
Tractor Meeting and Production Forum
Hotel Schroeder, Milwaukee Wis.

October 11-15
Aeronautic Meeting
Aircraft Production Forum, and Aircraft Engineering Display
Hotel Statler, Los Angeles, Calif.

October 31-November 2
Transportation Meeting
The Chase, St. Louis, Mo.

November 2-4
Diesel Engine Meeting
The Chase, St. Louis, Mo.

November 9-10
Fuels and Lubricants Meeting
The Bellevue-Stratford
Philadelphia, Pennsylvania

1956 SAE National Meetings . . .

January 9-13
Annual Meeting
The Sheraton-Cadillac Hotel and Hotel Statler, Detroit, Michigan

March 6-8
Passenger Car, Body and Materials Meeting
Hotel Statler
Detroit, Mich.

March 19-21
National Production Meeting and Forum
Hotel Statler, Cleveland, Ohio

April 9-12
Aeronautic Meeting
Aeronautic Production Forum, and Aircraft Engineering Display
Hotel Statler, New York, N. Y.

June 3-8
Summer Meeting
Chalfonte-Haddon Hall
Atlantic City, New Jersey

About SAE Members

WILLIAM B. BERGEN has been promoted to executive vice-president of The Glenn L. Martin Co. He will also retain his title of vice-president of operations of the company. Bergen is currently meetings vice-chairman of the SAE Aircraft Activity Committee.

CHARLES H. KING has been elected to serve on the board of directors for Clark Equipment Co. The company has increased the number of members on the board. A member of the organization since 1925, King is vice-president of the company in charge of operations of Clark's Automotive Division.

WALTER H. HOLCROFT, executive vice-president and technical director of Holcroft & Co., Detroit, has been presented the Trinks Award. This award is the nation's top honor for achievement in the industrial heating industry.

Holcroft was cited for his outstanding contributions to gas carburizing and carbo-nitriding in heat treating steel. He was also selected because of his contributions to short-cycle malleable annealing furnaces and improvements on standard type conveyor furnaces.

JOHN C. HOLLEY has been appointed vice-president and director of sales for Holley Carburetor Co. He has been general sales manager and a member of the board of directors since 1946.

EDWIN R. STROH has been named vice-president and automotive sales manager. Stroh joined the company in the fall of 1947, after serving in a sales capacity with a leading automotive parts producer. He has been automotive sales manager since 1951.

ARLEIGH J. HESS, long associated with the company's aircraft activities, has been named manager of the aircraft division. He was formerly aircraft sales manager.

DANFORTH HOLLEY has become vice-president of public relations and new products. He began working for Holley in 1937, and served in various capacities until his appointment in 1951 as cost savings director.

ALBERT F. POLK, vice-chairman, Sheffield Corp., Dayton, Ohio, has accepted the invitation of the Business and Defense Services Administration, Washington, D. C., to serve for a limited period of time as chief, Facilities, Distribution and Inventory Branch, Metal Working Equipment Division. He will take over his new duties in May and will have his offices in the Department of Commerce Building.

EDWIN A. SPEAKMAN has become a vice-president of the Fairchild Engine and Airplane Corp. He joined Fairchild in 1952 after serving for two years as vice-chairman of the Research and Development Board of the Department of Defense.

Bergen

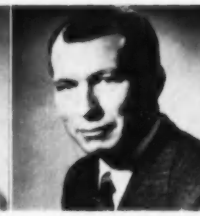
C. H. King

Holcroft

J. C. Holley

Stroh

D. Holley



Polk

Speakman

DR. D. P. BARNARD, research coordinator in the Research Department of Standard Oil Co. of Indiana and SAE President in 1952, is on a trip through Europe. Barnard returned recently to Standard Oil of Indiana from a one year leave of absence during which he served as Deputy Assistant Secretary of Defense in charge of research and development of the U. S. Department of Defense.

The itinerary for his current trip includes such spots as Copenhagen, Munich, Venice, Lucerne, Paris, Amsterdam, and London. After stopping at Birmingham, Derby, Chester, Edinburgh, and Glasgow, he will depart for New York July 12. His wife, Eleanor, is accompanying him on the journey.

DONALD M. BERGES is now vice-president in charge of manufacturing at Master Electric Co., Dayton, Ohio. He has been serving as works manager.

R. S. BRIGHT now heads the new manufacturing division of Chrysler Corp., embracing four of the company's plants in Indiana. He will serve as general manager of this new Supply Division. He previously directed the plants' operation under Dodge Division.

GEORGE W. WALKER has been elected vice-president and director of styling for Ford Motor Co. Styling responsibilities previously held by the company's engineering staff recently were transferred to **L. D. CRUSOE**, executive vice-president in charge of the car and truck divisions. Walker will direct styling activities as a member of Crusoe's staff.

F. W. SLACK, executive engineer, Chassis Design Section, Chrysler Corp., has retired from that organization. He had been with the company since 1933.

In 1935 he was advanced to chief engineer of the Chassis Design Section. Sixteen years later he became executive engineer of the Chassis Design and Development Section, as well as Ordnance and Defense Product Engineering.

N. F. HADLEY has also retired from Chrysler. He had been serving as chief resident engineer.

Hadley worked as chief experimental engineer when he was first hired by Chrysler in 1920. In 1930 he was appointed chief engineer of the Plymouth Division, the position he held until he was named chief resident engineer of the Engineering Division in 1953.

S. LEROY CRAWSHAW is now associated with Philadelphia Gear Works, Inc. as assistant to the president. He is the author of many technical articles, including Gearing Section of **Kent's Mechanical Engineers' Handbook**, and holds several patents in the gearing art as applied to oil and marine industries.

WILLIAM E. LIESMAN has been appointed assistant sales manager of the Parish Pressed Steel Division, Dana Corp. He joined Parish in 1946 and has been active in liaison engineering work between this Dana plant and the automotive manufacturers in Michigan who purchase chassis frames from the Parish Division.

WILLIAM H. KIEBER, formerly assistant chief engineer, has been advanced to the new position of engineering and sales consultant for Gabriel Co., Cleveland, Ohio. His new responsibility will encompass supervision of the complete Gabriel research and engineering service for additional manufacturers contemplating the use of damping devices to improve their products.

WILLIAM G. PATRIQUIN, former research engineer, has been appointed assistant chief engineer, replacing Kieber. In his new position he will assist **RALPH WHISLER**, chief engineer of the Gabriel Co., in design, development, and production of all types of damping devices.


Crawshaw


Liesman


Patriquin


Kieber


Lyon


Gwyn


Tucker


Hoke


Virtue


Fink


Zeitlin


Strother

BYRON T. VIRTUE, member of SAE since 1947, has been elected vice-president of engineering of Torrington Co., Torrington, Conn. Torrington operates 10 plants in the United States, Canada, England, and Germany for the manufacture of anti-friction bearings, industrial machine needles, swaging machines, precision metal parts and products, and bicycles and cycle parts.

Virtue joined Torrington in 1945 as assistant chief bearings engineer and shortly thereafter became chief engineer, Bearings Division. He is the first to occupy the newly-created position.

He is a member of American Society for Engineering Education and has been a member of the ASEE Committee for Accrediting Engineering Curricula. Also, he is vice-chairman, Power and Machinery Division, American Society of Agricultural Engineers.

FRANK W. FINK has joined Ryan Aeronautical Co. as vice-president and chief engineer. He moved to Ryan from Convair Division, General Dynamics Corp., where he had been chief engineer.

Besides serving on SAE Council during 1948-1949, Fink has held the post of SAE Vice-President representing Aircraft Activity in 1954.

WILLIAM H. BUDERUS, staff engineer for the Sinclair Refining Co., retired on Jan. 1 after having served 22 years in that position.

G. ALBERT LYON, SR. has been elected chairman of the board of Lyon, Inc., Detroit. He has been succeeded by his son as president of the firm.

Lyon, Sr. has been well known in the automobile industry since 1915 both as inventor and manufacturer. During his long career he has gotten over 2000 patents, including domestic and foreign. He founded Lyon, Inc. in 1930 and was its first president.

CHILDRESS B. GWYN, JR. is now associated with General Plate Division of Metals and Controls Corp., Attleboro, Mass. as technical advisor to the sales and engineering divisions. He also will serve as technical advisor to the sales, research, design, specification, manufacture, and development functions of the Electrical Contact Materials Division.

Gwyn had been general manager of Tungsten and Sintered Metal Divisions of the H. A. Wilson Co., Union, N. J. He has a wide variety of issued and pending patents covering numerous electrical contact alloys, fabricating and assembly processes, and self-locking nuts.

JOHN W. TUCKER is now serving with Cummins Engine Co. as a regional representative with headquarters in Los Angeles. Tucker has served the truck and industrial power industry in Southern California for 25 years. He joined the Cummins distributor for Southern California, Cummins Service & Sales, in 1952 as manager of industrial sales.

M. J. HOKE has been named vice-president and general manager of the crankshaft and camshaft division of Ohio Crankshaft Co., Cleveland. He joined the company in 1945 as a development engineer and became works manager in 1948.

W. C. DUNN, co-founder and president of Ohio Crankshaft since it was organized in 1920, while retiring from routine business activities, continues his long association with the company in the capacity of board chairman. His company is the largest independent producer of crankshafts and camshafts for gasoline and diesel engines.

ALEXANDER ZEITLIN has been elected vice-president of the Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa. He will continue to serve as president of Engineering Supervision Co. of New York, acquired by Birdsboro.

Zeitlin has been vice-president and general manager of Loewy Construction Co. and vice-president of Hydropress, Inc. for the past six years.

ROBERT G. STROTHER has become the new Eastern district manager for Magnaflux Corp. He has been serving as Western manager in Los Angeles.

White Motor News

Black

ROBERT F. BLACK has been elected to the newly-created position of chairman of the board at White Motor Co. He has also been re-elected president and chief executive officer of the company.

At the same time, vice-presidents **J. N. BAUMAN** and **V. W. FRIES** were named executive vice-presidents.

Bauman

Fries

Bauman, previously vice-president of sales, will function as head of White Truck Division. Fries, formerly vice-president of production, will have responsibility for coordinating manufacturing and distribution of current and new products not strictly automotive, both commercial and Government, that White will produce in all plants.

E. F. NORELIUS has retired after 30 years with Allis-Chalmers Mfg. Co. He was one of the early leaders and pioneers in crawler tractor development.

Norelius joined Allis-Chalmers as chief engineer. He became consulting engineer in 1944 after serving two years in active service as a colonel in the U. S. Army.

He has been a member of SAE for 35 years and at present a member of the Technical Board. Also he serves on the Construction and Industrial Machinery Technical Committe. From 1926–1942 he was active on the Ordnance Advisory Committee. Later he became chairman of the Vehicle Trafficability Committee.

WILMER AUGUST SPITZER, previously engine representative for Caterpillar Tractor Co., has attained the new position of district representative in Boise, Idaho.

RAYMOND W. SCHULTE has been elected to the position of Gary dealership manager for the Mack Truck Co. He was formerly service manager for Mack.

S. J. ROGERS, previously material quality manager for the Ford Motor Co., has recently been appointed to the position of assistant manager, Quality Control Department.

CHARLES L. RENO is now product analyst for the Chrysler Sales Division of Chrysler Corp. He formerly was on special assignment to the director of service at Chrysler.

DON L. CLITHERO, formerly district manager of the midwest area for Kewanee-Ross Corp., has been transferred to Buffalo, N. Y. and now holds the position of sales manager.

WALTER H. FREITAG has taken the position of project engineer with Clark Equipment Co., Buchanan, Mich. He formerly was associated with the Oliver Corp., as hydraulic engineer.

KENNETH C. EDSON has taken the position of petroleum additives specialist, E. I. duPont de Nemours & Co., Inc. He had previously served as manager of the Western Regional Laboratory with duPont.

ROBERT ALVIN VOGELEI has recently joined the staff of the Chevrolet Central Office as senior project engineer. He had been senior project engineer at the Cadillac Motor Car Division.

Vogelei has been an active member of the Cleveland Section since 1952.

ARUN PRASAD has joined the staff of Tata Locomotive and Engineering Co., Ltd., Tatanagan, Jamshedpur, India as a mechanical engineer. He formerly was test engineer for the Massachusetts Institute of Technology.

EARLE H. STEPP has recently acquired the position of structures engineer for Convair Division, General Dynamics Corp., Fort Worth, Texas. He was previously connected with Chrysler Corp. as a test and development engineer.

LEE J. BREGENZER, former member of the Aviation Committee (Mct Section) is now associated with North American Aviation, Inc. as senior-mechanical design engineer. He previously was plant engineer at Industrial Products Division—Westinghouse Airbrake Co.

ROBERT S. PETERSEN has been appointed project engineer for Haskel Engineering Associates. His new duties involve the design of high pressure gas boosters and the supervision of engineering for aircraft ground handling equipment.

Petersen previously held the position of senior engineer with the same company.

WILLIAM AUGUST VAHS is now associated with Parker Appliance Co., Cleveland, Ohio, as senior project engineer. He was previously associated with Detroit Harvester Co., Warner Division as project engineer.

HARRY P. WESTON has recently organized his own company—Service Station Publishing Co.—which publishes a business magazine for service station operators and oil company marketing men in Toronto, Ont., Canada.

He formerly was manager of the Business Magazines Division of Consolidated Press, Ltd.

OTTO H. FEDOR is now associated with Reaction Motor, Inc., as test engineer. His new position entails designing, and maintaining instrumentation and testing facilities for rocket engines.

He previously held the position of assistant project engineer at Curtiss-Wright Corp.

Changes at Ford

With the establishment of separate Lincoln and Mercury Divisions and a Special Products Division, Ford Motor Co. has formed three individual engineering car offices to service each of the new divisions.

HAROLD C. MacDONALD, formerly chief advanced vehicles engineer, has been promoted to director of the Mercury car engineering office. **J. J. FELTS** will serve as his executive engineer.

HARLEY F. COPP, chief product engineer for the Continental Division, has been named director of the Lincoln car engineering office.

NEIL L. BLUME, executive engineer in charge of Lincoln and Mercury car engineering, has been promoted to director of the special products engineering office, with **B. T. ANDREN** as executive engineer.

In addition, a new engine and electrical engineering office has been established under the direction of **ROBERT STEVENSON**, with **PAUL M. CLAYTON** and **L. L. BELTZ** as executive engineers. Also newly formed is an advanced product study and engineering research office under **VICTOR G. RAVIOLO**, formerly director of the Lincoln and Mercury car engineering office.

ALONZO M. HAPP has joined American Machine and Metals, Inc., as general sales manager. Happ was previously connected with Connecticut Telephone & Electric Corp., Meriden, Conn., as vice-president and general manager.

MARTIN L. HEADMAN, formerly assistant supervisor of design engineering, Western Gear Works, Lynwood, Calif., has been appointed to the new position of engineering representative.

EDWIN R. JONES has assumed the position of sales engineer for Van Der Horst Corp. of America. He previously was a jet fighter pilot and aircraft maintenance officer at Moody Air Force Base, Ga.

PHILIP G. DEHUFF is now assistant to the manager, PWR Project at Westinghouse Electric Corp. Atomic Power Division. He formerly held the position of manager, Production Engines Division, at Westinghouse Aviation Gas Turbine Division.

DeHuff has been active on SAE Aeronautic Production Forums for the last three years in New York City.

PHILLIP B. GARNER has been appointed to the position of preliminary design engineer of AiResearch Mfg. Co. of Ariz. He had been senior process engineer for AiResearch in Los Angeles.

DALE E. BARTHOLOMEW, formerly project engineer at Reo Motors, has joined Chrysler Corp.'s Engineering Division as forward control design supervisor of truck chassis.

PAUL EDWARD FALKNER, who has been eastern representative of the Transportation Newspaper Division, Maclean-Hunter Publishing Co., Ltd., has been appointed to the position of advertising manager of **Bus & Truck Transport Magazine.**

Falkner has been a member of the Governing Board as field editor for the Montreal Section.

FRANK J. OPATRNY has acquired the position of director of marketing at Hupp Corp., Cleveland. He was formerly with the Perfection Stove Co. as supervisor of winterization.

ARTHUR J. DAVIDSON, JR. has joined the Budd Co.'s staff as assistant executive engineer. He formerly was with Chrysler Corp. as project engineer.

DAVID KAYNE NASON has taken the position of technical service representative for the Texas Petroleum Co., Accra, Gold Coast, Africa. His new duties entail giving technical service and lubrication recommendations for his company's customers in the Gold Coast and Togoland, West Africa.

Nason previously held the position of group leader of the Products Application Department, Texas Co., N. Y.

Rosen Honored By Bradley U

ROSEN IS CONGRATULATED by Dr. H. P. Rodes, President of Bradley University, as the degree of Sc.D. is conferred on him. The citation honored him as a world-renowned research scientist and engineer.

C. G. A. Rosen, 1955 President of SAE, was honored by Bradley University, Peoria, Ill., on June 6, in recognition of his distinguished career as an engineer, scientist, and lecturer. He was given an honorary Doctor of Science Degree by Dr. H. P. Rodes, University President, before a commencement gathering of 3000 students and friends.

R. E. Gibbs, Dean of the School of Engineering, read the citation, which is quoted below:

"Mr. President, the gentleman whom I have the pleasure of presenting is a world renowned research scientist and an outstanding leader in his profession.

"He is currently consulting engineer to the president of the Caterpillar Tractor Co., and President of the Society of Automotive Engineers.

"By combining a mastery of research insight and a high degree of technical competence with an acute awareness of the responsibilities of his profession, he has distinguished himself throughout the world as an engineer, scientist, and lecturer.

"He is a member of numerous technical societies, including the British Institution of Mechanical Engineers, and was their James Clayton Lecturer in 1950.

"It is my privilege, Mr. President, to present for the degree of Doctor of Science, the eminent research scientist, engineer, and lecturer, Carl George Arthur Rosen."

ARTHUR W. JUDGE, consulting automobile engineer of Farnham, Surrey, England, has recently published a Fourth Edition of his book on The Testing of High Speed Internal Combustion Engines.

In this new edition, new information and data have been included in regard to methods and instruments concerned with measurements of fuel quantity and rate, exhaust gas composition, diesel engine smoke density, static and variable cylinder pressure and temperatures, air consumption, speed, and certain other quantities involved in engine test and test analysis.

ERNEST A. MAGYAR, formerly affiliated with Titeflex, Inc., N. J. as a sales engineer, has taken the position of sales engineer at the Circle Clamp Corp.

HARRY T. WILLIAMS, formerly test engineer for Continental Motors Corp., has taken a position as sales engineer at Chrysler Corp.

H. A. MURRAY has been made assistant manager of the Aviation Department of California Texas Oil Co. He will be concerned with marketing to airlines around the world, except North and South America. He has been on tour of Australia, New Zealand, Indonesia, and the Philippines in connection with this new job.

GEORGE A. JOHNSON has retired as administrative assistant to the general manager of Rochester Products Division, General Motors Corp. He has been enjoying life on tour of the South and Guatemala. He looks forward to more of the same.

SETH P. NORDLING is now associated with Caterpillar Tractor Co. as designer. He had previously been design engineer for Hyster Co., Portland, Ore.

JOHN F. HAINES, formerly vice-president and chief engineer of McCauley Industrial Corp., Dayton, Ohio has joined the atomic energy engineering department of the American Locomotive Co., Schenectady, N. Y. He will serve in the capacity of chief development engineer, working on atomic products.

FREDERICK J. BURKE has acquired the new position of industrial engineer on the executive staff of the Detroit Harvester Co. Burke formerly was with Ford Motor Co. as supervisor of the Dearborn General Mfg. Division.

F. S. KUBIAK is now an engineer with Wisconsin Motor Corp., Milwaukee. He formerly was quality control engineer with Westinghouse Air Brake Co.


F. W. Telford


R. J. Telford


H. King


Davis

FRANK W. TELFORD has retired after 38 years of service in the Detroit Sales Office of the Goodyear Tire & Rubber Co. He has actually been associated with the company for more than 44 years as he first joined as general line salesman in 1910. He was made manager of the Detroit office in 1937. In recent years he has been serving in the position of sales consultant.

R. J. TELFORD is resigning as Canadian branch manager of Reo Motor Truck Co. to become vice-president and general manager of the Freuhauf Trailer Co. of Canada. He will assume his new duties on August 1.

Telford had served as vice-president and general manager of Reo of Canada's manufacturing plant before its purchase by Bohn Aluminum and Brass Co. Since then the Canadian Division has been operated as a branch with Telford in charge.

HART M. KING was among the 29 persons awarded Sloan Fellowships by the school of industrial management of Massachusetts Institute of Technology. He will study an executive development program at M.I.T. for one year.

King is on the Engineering Staff of Ford Motor Co. as section supervisor, Vehicles Testing Department.

FRANCIS W. DAVIS, consulting engineer, built the first hydraulic power steering gear in 1925. This gear has now been accepted by the National Museum of the Smithsonian Institution as a part of that historical collection.

Davis, a prominent SAE member, has been active both in New England Section and national activities. He became a member of SAE in 1916. He served on the Council during 1921–1922.

ARTHUR J. SCAIFE, 1932 SAE President and Life Member of the Society, got more information about a nephew and namesake from the 1955 SAE Roster than he had in twenty previous years.

When he looked for his own name in the current Roster he found it all right, but there seemed to be something wrong with the title and address. Past President Scaife has been retired for some years now, lives at 6509 2nd Ave.,


A. J. Scaife


A. J. Scaife

St. Petersburg, Fla. . . . He blinked when he saw after his name in the Roster: "designer, Saginaw Steering Gear Division, GMC, Saginaw, Mich." . . . So, he wrote John Warner at SAE Headquarters, learned there was a new **ARTHUR J. SCAIFE** who had joined SAE in 1954, then recalled: "I had a brother Edwin living in Michigan years ago. He had seven children, one of whom was named for me!"

In the meantime, Past President Scaife learned that his own card with his membership starting in 1910 had just plain been omitted from the 1955 list. So, the 1956 Roster will positively list two Arthur J. Scaifes!

SNOWMAN W. DOE, who had been a service instructor for the Ford Motor Co., has recently joined Mack Mfg. Corp.'s staff as service engineer.

CLIFFORD M. MARTTILA is now senior designer for Chevrolet Motor Co. He previously had been affilated with Creative Industries of Detroit as design checker.

RICHARD C. DEVEREAUX has been elected president of Ferro Stamping Co., Detroit. He succeeds his father William C. Devereaux, who founded the firm in 1915 and now takes the newly created post of board chairman.

Devereaux has served the company for 20 years.

MAC GOLDSMITH, managing director of Metalastic Ltd., England, has recently been appointed chairman of the company.

John Bull Rubber Co., Ltd. has also appointed him deputy chairman and joint managing director of their company.

from the Sections

Northern California

Field Editor R. E. Van Sickle
May 18

CREATIVENESS CAN BE DELIBERATE was the thought presented by SAE President C. G. A. Rosen to members and guests of the Northern California Section at the recent Presidents' Meeting.

Speaking on the subject, "In Quest of Creativeness", Rosen stated that everyone has the urge to explore, and that through cultivation, this desire can produce a state of deliberate creativeness which should be more productive than random type thinking. He believes that the factors involved in achieving this deliberate creativeness include reading in the fields of interest, sketching prolific preliminary designs, constructing models to resolve complexities, making laboratory experiments, promoting verbal exchanges and discussions, testing opposites, and exploring limits of possibilities.

Preceding the President's address, C. A. Winslow, president, Winslow Engineering Co., reviewed for the group the highlights in automotive developments and SAE activities on the West Coast during the past half century.

Cleveland

Field Editor W. B. Fiske
May 9

THE WIDEST CONTINUOUS STEEL STRIP IN THE WORLD is produced in the continuous strip mill of the Republic Steel Corp. This strip is **98 in. in width.** SAE members and guests of Cleveland Section toured through the plant and witnessed both hot and cold rolling of steel.

Four members of the Republic organization spoke to members about the various activities of the plant. Charles W. Cravens, assistant district manager, welcomed the engineers; Peter Letcavits, general superintendent of the strip mill, explained the overall operations and capacities of the mill; Harold E. Craig, plant metallurgist, described the melting of automobile steel in open hearth furnaces and preparation of slabs for the strip mill; and Harold L. Farling, chief metallurgist, discussed the rolling of steel in the continuous mill. A question and answer period followed.

Southern New England

Field Editor A. D. Nichols
May 20

TREASURER OF SOUTHERN NEW ENGLAND SECTION FOR TEN YEARS, Henry J. Fischbeck, Pratt & Whitney Aircraft Division, United Aircraft Corp., was presented with a special gift on his retirement as treasurer. It was also announced that Fischbeck is retiring from his duties with Pratt & Whitney.

1954–1955 Section Chairman Harry Nystrom was also presented with a gift at this annual spring social gathering at the Rockledge Country Club in West Hartford.

Washington

Field Editor Bob Auburn
May 17

LIFE ON THE FIRST SPACE SHIP was the novel and entertaining discussion by Andrew J. Haley, Past President of the American Rocket Society at this annual Ladies Night program. Gravitationless existence, housekeeping on Mars, time schedules to Mars, Neptune, Saturn, and thence on to Alpha Ontares were some of the topics.

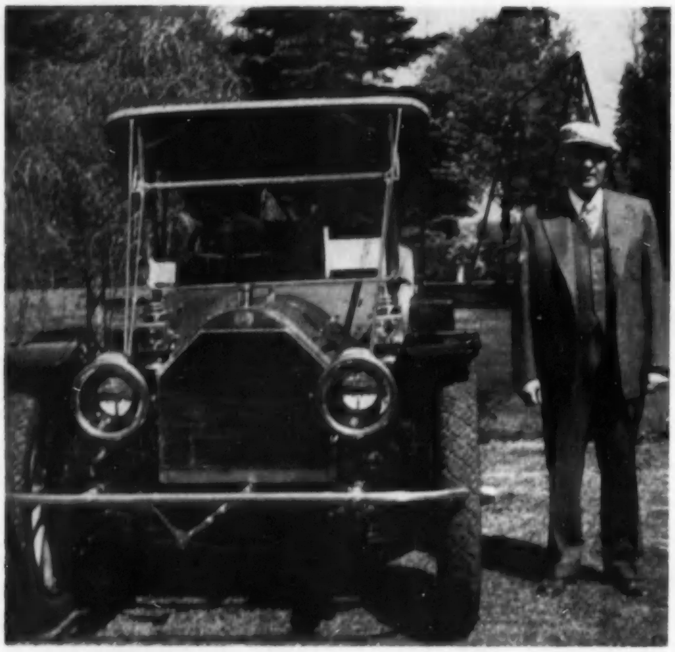
In a review of rocket development, Haley pointed up the increases in exhaust velocities, forecasting **velocities up to 24,000 ft per sec for chemical fuels.** Eventually, far greater velocities are likely to be reached with fission or fusion type power plants.

A film entitled, "Horizons Unlimited," was shown to illustrate rocketry advances.

Haley made the prediction that if funds and manpower were available to do the job, **a rocket to successfully reach the moon could be developed within ten years time.** In describing the kind of meticulous housekeeping required on a space vehicle, Haley em-

From Section Cameras

Pittsburgh June 6



WINNER OF THE ANTIQUE CAR COMPETITION at this Pittsburgh Section meeting stands here beside his 1909 Chalmers. Frederick E. Haller, owner and manager of Lebanon Garage Co., Pittsburgh, walked away with first prize for this beautifully preserved model.

Northern California—South Bay Division

ATTENDING A GOVERNING BOARD MEETING for South Bay Division are many SAE dignitaries. Seated clockwise are E. W. Rentz, SAE West Coast manager; W. G. Brown, 1955–1956 Northern California Section chairman; W. H. Moranda, Wetmore Hodges & Associates, Inc.; G. R. Picolet, Division placement chairman; J. V. Harris, Division treasurer; J. R. MacGregor, 1954–1955 Northern California Section chairman; F. L. Jarrett, Division program chairman; C. F. Carey, Division field editor; F. W. Fingerle, Division membership chairman; SAE President C. G. A. Rosen; W. A. Casler, Division publicity chairman; R. A. Hundley, 1955–1956 Division chairman; and W. J. Adams, Jr., 1954–1955 Division chairman.

phasized the need for utmost conservation of all life sustaining materials.

Magician George W. Farmer entertained the meeting with an outstanding sleight-of-hand exhibition. More serious business consisted of the announcement of next year's slate of Section officers, and the presentation of a past-chairman's certificate to outgoing Chairman Doug Bonn.

Pittsburgh

Field Editor D. W. Gow
June 6

AS A SPECIAL FEATURE OF THE ALL-DAY SPRING OUTING at the Wanango Country Club, Reno, Pa., a number of antique cars were displayed by the Horseless Carriage Club. In competition for the best conditioned car were a 1903 Cadillac, 1908 Maxwell, 1909 and 1911 Chalmers, 1911 Overland, 1920 Dodge, and 1923 Ford. Winner was the 1909 Chalmers owned by F. E. Haller.

Speaking on the subject "Where Did It Come From," 1948 SAE President R. J. S. Pigott described the evolution of today's automobiles from the early steamers and one-lungers. Pigott emphasized the fact that the fifty-five year period is lined with improvements which are largely skilled design rather than basic invention. More than half the gain in horsepower per cubic inch over the past forty years has been due purely to mechanical improvements.

Texas Gulf Coast

Field Editor G. W. Putney
May 13

REPRESENTING SAE PRESIDENT C. G. A. ROSEN. W. C. Heath gave a short talk on SAE at this Golden Anniversary meeting of Texas Gulf Coast Section. Heath, executive engineer—marketing for Solar Aircraft Co., is a member of SAE council for the term of 1954–1955.

Officers for the coming 1955–1956 term were then installed in a short business meeting before the dinner-dance got under way.

Williamsport

Field Editor B. L. Sharon
May 2

WE ARE NOW IN THE ATOMIC AGE AND MUST ADJUST OUR LIVES WITH THIS THOUGHT IN MIND, stated H. F. Matthiesen, supervisor—Contracts of General Electric Co.'s Aircraft Nuclear Propulsion Department. Matthiesen's topic, "The Atom and You," was presented before 75 members and guests.

The fact that our whole concept in the development of power, the possibilities in medical research, and the power of destruction are just now being explored means that **we must acquaint ourselves with the fundamentals of the atom.** The General Electric film, "A is for Atom," was shown. This production explained the structure of the atom and radioactivity as well as the concept of the release of neutrons carrying the principle through to the chain reaction.

Matthiesen answered many questions from the audience. It was brought out during this period that man has been subjected to radioactivity from the sun since time began. With strong sources of radiation on hand, it is necessary to take all precautions in protecting the people working in this field as well as develop protective means for the whole population.

Central Illinois

Field Editors Y. Miller and E. E. Hanson
May 23

TORQUE CONVERTERS IN THE TESTING STAGE have a utility ratio of 6/1 instead of present 3½/1, and stall torque ratio of 6/1 instead of present 5/1.

W. B. Gibson, sales manager, Hydraulic Division, Twin Disc Clutch Co., spoke on "The Torque Converter Manufacturer's Dilemma." Gibson believes that in order to satisfy industrial requirements, torque converter and engine manufacturers alike will have to make more detailed analyses of the problems involved in each application. He explained that the three basic characteristics affecting performance are the primary torque curve, the efficiency and utility ratio, and the torque capacity. The three mechanical design features that affect performance are the stationary housing, the rotating housing, and the clutch type and location.

Milwaukee

Field Editor F. B. Esty
May 6

A SAVING OF $15,500,000 was made possible by the merger of Hudson and Nash departments. If Hudson and Nash had continued independently and each had tooled to build the present line of cars, it would have cost $25,000,000. In the combined effort of design, tooling, and the use of equipment at maximum efficiency, the job was done with an expenditure of $9,500,000.

These figures were quoted by Earl L. Monson, assistant chief engineer, American Motors Corp. His paper was entitled, "American Motors' First Year."

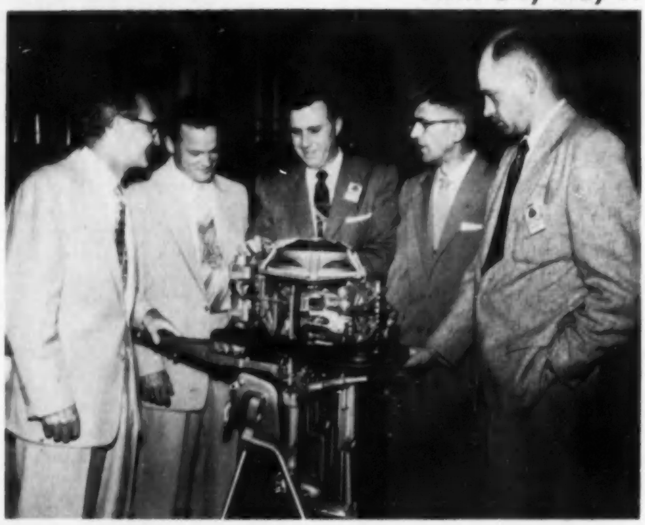
A merger with Hudson was more logical at the time it was accomplished than with any other independent for the following reasons:

1. Hudson's "Monobilt" construction was enough like Nash's "Unitized" method in which body and frame are one welded unit, that **a change-over to one assembly line for two series of cars was much easier to bring about** than with other makes of cars.
2. Because of this basic similarity of design, **car production could be consolidated in the same plants.**
3. Hudson dealers, with the Jet Series, who were already active in the market for compact cars,

New England May 10

A MINUTE MAN MUSKET was presented to John A. C. Warner, SAE secretary and general manager, by New England Section. Examining the relic at the Golden Anniversary meeting are (left to right) Robert Gardner, SAE vice-president representing Transportation and Maintenance Activity; John A. C. Warner; and Gus Heiber, New England Section chairman.

Twin City May 11



AN OUTBOARD MOTOR IN MODERN STYLE stands under the scrutiny of members and guests of Twin City Section. Shown in this group are (left to right) speaker L. D. Watkins; 1955–1956 Section Chairman Leslie W. Foster; 1954–1955 Section Chairman Donald Breining; Walter J. Raleigh, Minneapolis-Honeywell Regulator Co.; and Robert De Ghetto, E. B. Sewall Mfg. Co.

British Columbia May 9

FOUNDING CHAIRMAN OF BRITISH COLUMBIA SECTION P. J. Schrodt is shown seated before other notables of this Golden Anniversary meeting. Standing (left to right) are SAE Councilor John Holmstrom; 1954–1955 Section Chairman James Mortimer; Section Secretary Burdette Trout; and speaker A. D. McLean, Kenworth Motor Truck Corp.

were ideally qualified to sell the increasingly popular Ramblers.

Monson went on to describe the methods with which some of the major changes, such as wrap-around windshields, were incorporated; how changes in existing parts were modified to meet requirements of both lines; how facilities in one division were meshed with requirements of another to implement the savings that had been anticipated.

New England

Field Editor G. T. Brown
May 10

MAN IS FACED WITH TWO DISTINCT TYPES OF PROBLEMS—those that have one and only one right solution, and those that have many adequate solutions. The first class is termed analytical, the second is classified as creative. It is in the second category that the great bulk of our creative engineering problems lie.

These were the opening remarks of speaker John E. Arnold, associate professor, Mechanical Engineering, Massachusetts Institute of Technology.

The creative process is a process of mental activity in which one combines past experience with present experience with possibly some distortion, in such a fashion that one arrives at new combinations, new patterns, and new configurations that better satisfy the needs of man. This need may be an implied need just as well as an expressed one, but in every case, the creative process is not completed until one produces some tangible evidence that the need has been satisfied.

This significant paper, "Creativity in Engineering," followed the ceremony in which Dean Fales, research associate, MIT, presented John A. C. Warner, SAE secretary and general manager, with a "Minute Man" musket. Robert Gardner, SAE vice-president representing Transportation and Maintenance Activity, then forwarded greetings from President C. G. A. Rosen. He brought cordial good wishes for an even greater success for the future half of the century. Gardner stated that a great deal of our country's success can be attributed to the amazing advancement of transportation both in peace and war. By contrast, Brazil was an example of many parts of the world where food and vital commodities were spoiled and rendered useless because of lack of good transportation facilities.

Twin City

Field Editor R. V. Rosenwald
May 11

APPROXIMATELY ONE-HALF OF EUROPE TRAVELS ON 2-CYCLE ENGINES, stated L. D. "Denny" Watkins, chief research engineer for the Outboard Marine and Mfg. Co. These engines are usually loop-scavenged as compared to the cross-scavenged American engines. Consequently they have better high speed performance with poor idling characteristics, while our engines operate better at the lower speeds. Part of Watkin's talk was a discussion of slides taken at a technical show in Germany. Small German engines are very plentiful. They are built for bicycles, motorcycles, and small cars.

A discussion of early outboards, those of the 1900 era, was presented by Watkins. These included the early Waterman Motors and the old American Engine. About 1909, Ole Evinrude produced his first outboard. These outboards were **purely functional with very little thought for styling.** Improvements came gradually; gear housings, weedless operation, weight reduction, magnetos, reverse gears, remote fuel tanks, die cast aluminum parts, and quiet operation. All have been incorporated over the years. It took 20 years to get rid of the "knuckle buster" starter knob.

The 2-stroke cycle engine was chosen for its simplicity, low cost, fewer moving parts, and higher speeds.

German outboards are, to all outward appearance, similar to ours. However, they lag behind us primarily because their lakes and rivers are neither plentiful nor good. The 3 hp German engine is the same weight as our 5 hp engine.

The future for outboards indicates **lighter, quieter engines which start easier and are well styled.**

British Columbia

Field Editor J. B. Tompkins
May 9

SAE HAS BEEN BUILT WITH EACH SECTION AS A CORNERSTONE OF THE SOCIETY said John G. Holmstrom, vice-president and general manager of Kenworth Motor Truck Corp. As a member of SAE Council for the term of 1954–1955, Holmstrom represented SAE President C. G. A. Rosen at this Golden Anniversary meeting. He payed tribute to Rosen, who reviews the 50-year history of the Society by looking forward with only a quick look behind.

Holmstrom showed how SAE Sections have adapted themselves to local conditions and studied geographic problems. He cited as an example the prominence given maintenance problems by West Coast Sections as compared with the underlining of manufacturing problems in the east.

Philip J. Schrodt, first SAE Chairman in Vancouver when the Section was formed as a Group nine years ago, traced the development of SAE in British Columbia from the depression and pre-World War II era to the present time. He payed special tribute to the assistance of members of Seattle's Northwest Section in the founding of British Columbia Section.

Technical speaker for the evening was Allan D. McLean of Kenworth. He outlined **developments in power steering on heavy on- and off-highway vehicles.** Though developments in the passenger car field had stolen the spotlight from heavy vehicles, McLean said **increases in front axle loadings up to 11,000 lb were making power steering essential on many trucks.** All power steering systems are designed to "fail safe," he claimed, in describing various applications. Selecting a power steering system is based almost entirely on the space available in the vehicle.

He forecast that production economies possible

Student Cameras

New York University March 16

25 YEARS OF SERVICE AS FACULTY ADVISOR of the New York University SAE Student Branch have been given by Professor E. H. Hamilton. He is shown at the right as he is being awarded a gold watch by NYU Student Branch Chairman Walter Shanler. The award was made at a meeting commemorating the 100th Anniversary of NYU College of Engineering, the 50th Anniversary of SAE, and the 25th Anniversary of NYU Student Branch.

Western Michigan May 16

FIRST PLACE AWARD in the technical paper competition sponsored by Western Michigan Section is given by T. J. Reeves (left), Section chairman, to Gordon Grant of Muskegon Community College. Other student winners are (left to right) Alan Manchesky, Norman Hine, and David Tietsort. Looking on is Dr. Llewellyn Heard, speaker from Standard Oil Co. of Indiana.

Oregon State College April 8

GUIDED THROUGH A PLANT of the Freightliner Corp. by Roscoe Clarke, sales engineer of the company, are members of Oregon State College Student Branch. Shown (left to right) are Verne Grimshaw, Arthur Vanbellinghen, Fred Johnson, Don Burkhart, Don Geri, Bob Pohl, Professor William Paul, Faculty Advisor, Bruce Medler, and Dick Reilly.

in connection with power steering in the passenger car field will be reflected during forthcoming years in greater acceptance and use in trucks.

St. Louis

Field Editor Gene Kropf
May 10

THE MYSTERIES OF FUEL ADDITIVES were thoroughly explained during a panel discussion meeting that closed the 1954–1955 year for the St. Louis Section. In a well planned program under the supervision of George L. Stetson, vice-chairman, Fuels and Lubricants, experts from several companies traced the "How's" and "Why's" of various types of fuel additives. An unusually large crowd kept the panel members busy from the floor.

R. K. Williams, assistant head of Fuels & Lubricants Department, Research Laboratory Division, General Motors, served as moderator for the discussions. Panel members included: W. E. Bettony, assistant director, Petroleum Laboratory, E. I. du-Pont de Nemours & Co., Inc.; D. P. Heath, assistant supervisor of Fuels Section, Research and Development Laboratory, Socony Mobil Oil Co., Inc., Paulsboro, N. J.; and J. C. Ellis, fuels group leader, Research Laboratory, Shell Oil Co., Wood River, Ill. While the panel members were able to answer most of the serious and technical questions, they did not have the answer for the question: "How about adding TCL?" (TCL, of course, stands for Two Cents Less).

Special guests at the Section meeting included: Hollister Moore, SAE manager of Sections and Membership Division, New York; J. D. Redding, SAE Vice-President representing Aircraft Activity, who represented and brought greetings from President C. G. A. Rosen; and Jack MacGregor, Chairman of the Northern California Section.

Metropolitan

Field Editor Leslie Peat
May 18

PASSENGER - CARRYING CONVERTIPLANES WOULD BE SPEEDIER AND MORE ECONOMICAL than any other type of carrier on 150 to 600 mile trips. The craft's speed and maneuverability would also be advantageous for such duties as carrying mail and making aerial surveys, as well as for military reconnaissance, rescue, and troop-carrying operations.

The speaker who made these statements at a meeting in Garden City, L. I. was William E. Cobey, president of Transcendental Aircraft Corp., Glen Riddle, Pa.

Cobey said his firm is now perfecting its Model 1-G, **the first tilting-rotor convertiplane to have flown successfully in the history of aviation.** He explained how his company's ship flies as a helicopter when its wing-tip rotor assemblies are vertical, and as an airplane when the assemblies are tilted forward to normal propeller position.

A convertiplane could take off vertically from the center of one city, convert to an airplane in the air and fly at 250 mph or better to another city, then change back to a helicopter and land safely at a downtown "convertiport," bypassing outlying airports.

This new type of passenger carrier may supplant busses and trains to an appreciable extent in the future, said Cobey.

Atlanta

Field Editor D. J. Tolan
May 2

GAS TURBINE PRODUCTION FOR AUTOMOBILES BY 1965 is predicted by Victor G. Raviolo, director of Lincoln and Mercury car engineering. This prediction is, of course, dependent upon relative advances made with piston engines.

Raviolo spoke on future trends in automotive power plants before Atlanta Section May 2. He told a packed house that **overhead camshafts, fuel injection,** and **increased bore-stroke ratio were likely prospects for engines to come.** Also wider acceptance of liquefied petroleum fuel is expected as distribution and handling techniques improve. These remarks were made by Raviolo at the final meeting of the Section during the Section year.

Proud of its record growth during this past year, the Section paid tribute to Jack S. Reid, 1954–1955 Section Chairman, for his wonderful work. Under his leadership, the Atlanta Group achieved Section status and organized an SAE student group at Georgia Tech.

Western Michigan

Field Editor W. C. Chaffee
May 16

REQUEST FOR A REPEAT PERFORMANCE of his "Fire Magic" talk brought Dr. Llewellyn Heard, research chemist of Standard Oil of Indiana, back to Western Michigan Section for this first annual Father and Son meeting. Dr. Heard explained **the scientific facts about combustion** with entertaining experiments and described them in language that both fathers and sons could understand and enjoy. He punctuated his explanations with smoke rings, green flames, and minor explosions in a masterful demonstration that thrilled and informed his audience.

This Father and Son meeting was utilized as a particularly appropriate occasion for inviting as many student branch members as possible. The opportunity was taken to present the awards for the Section-sponsored technical paper competition that has been underway. First-place award went to Gordon Grant of Muskegon Community College. This prize-winning paper is entitled, "The Principles of the Diesel Engine." Students who won other prizes were Alan Manchesky, Norman Hine, and David Tietsort.

Air Travel Reflects CAA Achievements

Based on paper by

EDGAR N. SMITH

Civil Aeronautics Administration

ONE of the Civil Aeronautics Administration's greatest contributions to safety in flight is the control of traffic en route which requires the ability to communicate air-to-ground and point-to-point. The CAA operates one of the largest and most complex communication systems in the world. By radio teletypewriter, its communications station in Honolulu, for example, is in around-the-clock contact with other CAA stations in San Francisco, Anchorage, Wake Island, Guam, and Canton Island.

CAA traffic controllers not only keep airplanes from colliding on landing and take-off at busy airports; they also keep track of traffic using the airways, and the long range traffic over oceans. By means of radio-telephone and wireless telegraphy, the traffic controllers can separate aircraft in several different ways. They can separate aircraft flying at the same altitude by maintaining longitudinal spacing of several miles between airplanes flying in the same direction, or by assigning different altitudes if flying in opposite directions. They can provide lateral separation along the right hand side of the airways.

The traffic control centers at Honolulu, Wake Island, and Guam keep track of air traffic over the Pacific in an area totalling more than 12,000,000 square miles. That is greater than all of the United States and Canada combined.

(Paper "The CAA—What It Is and What It Does" was presented at SAE Hawaii Section, Jan. 17, 1955. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Four Basic Ideas Get Aircraft Aloft

Based on paper by

DEL ROSKAM

Cessna Aircraft Co.

IN a general aircraft production system there are four principles to be kept in mind and employed. Know your people, is the first. The proper organization and application of people and their talents are by far the most difficult and yet rewarding accomplishment that any management can pursue. It is the basic challenge to industry today.

The second principle is to recognize the importance of master scheduling. It sets the pattern. Management must be aware that only it can control and change that master pattern when it gets out of balance. The operating management group can recognize danger signals and suggest what to do, but it cannot make decisions to change or correct.

Education is the third principle. Every foreman, supervisor, and department head must take the time to educate and inform each individual. It is part of the job and to be recognized as such.

Methods improvement, too, is everyone's job. And that's the fourth principle. Methods improvement is merely the organized application of common

sense to take the waste out of operations.

(Paper "A General Production System for Production of Aircraft" was presented at SAE Wichita Section, Nov. 13, 1954. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

encountered in hydraulic work. For most practical purposes, therefore, rubber may be considered as incompressible.

The force upon the piston creates a corresponding pressure on the confining walls. If these walls are thin enough to bulge under the pressure, there will be a corresponding change in shape of the material, but practically no change in volume. If the piston had a slight clearance in the cylinder, sufficient force on the piston would cause the rubber to flow into the clearance space. This is known as plastic flow, or cold flow, and is frequently encountered with o-rings, vees, cups, and other shapes where the fluid seal has been insufficiently backed-up either by the piston or a back-up washer of some material. Because this fact is either unknown or disregarded, much difficulty has been met in the past, and will be met in the future.

Since various synthetic rubbers are relatively non-porous, as compared to

Material All-Important In Fluid Seal Design

Based on paper by

ROBERT H. BARBOUR

and

ROBERT O. ISENBARGER

Chicago Rawhide Mfg. Co.

ENGINEERS lacking experience with elastomeric materials make the mistake of attempting to design fluid seals, thinking in terms of the properties of various metals. An elastomeric compound, such as common synthetic rubber, can be considered to behave as a fluid when it is flowing into the cavity during the closing of the mold and after it is cured or vulcanized. The statement that rubber is not compressible often surprises people due to their misunderstanding of the definition of "compressible." A material is compressible only if its volume can be changed by an applied force. This is illustrated by Fig. 1.

Consider the space between the closed end of a cylinder and a leakproof piston, the space being completely filled with rubber. The piston could be moved only by the application of an extremely high compressive force, or force greater than ordinarily

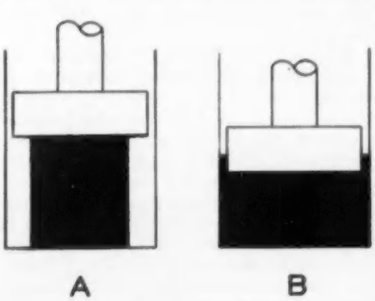


Fig. 1—Showing the incompressibility and flow characteristics of rubber. The volume of rubber under both pistons is identical. Pressure causes rubber in A to change shape and fill cavity. If clearance exists as shown in B, rubber will extrude around the piston.

a material like leather which stores lubrication, they usually have a high coefficient of friction and are subject to abrasion if not lubricated. Therefore, in dynamic applications care should be exercised to see that lubrication is present.

The hardness, smoothness, and material of the surface on which the fluid seal will operate is very important. On rotating shaft seals, for instance, steel shafts are usually recommended having a hardness between 45 and 60 Rockwell C. Hardened steel makes the best surface against which a seal operates. Softer materials such as copper, brass, and aluminum, particularly on rotating shafts, can be abraded rather rapidly by fluid seals, so it is best to protect them with a hardened steel ring or case.

Many seal failures are due to improper installation. Often insufficient space is allowed for the seal with the result that the seal which does fit in the space is inefficient.

(Paper "Fluid Seals" was presented at SAE Golden Anniversary Passenger Car, Body & Materials Meeting, Detroit, March 1, 1955. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Will Gas Turbines Conquer Truck Field?

Based on paper by

ALBERT R. HILLMAN

Fort Edwards Express Co.

TO perform like a passenger car, that is, to maintain 60 mph on a 6% grade, a rig of 50,000 lb gross weight would need about 700 hp, according to SAE Performance Prediction Procedure. That's four times our present levels of 165 to 200 hp for the same gross weight. But the gain in actual ton miles per day would be nothing like in this proportion.

The goal for the developers of new powerplants to pursue, therefore, is certainly not 700 hp. For the next five years we cannot count on any general increase in allowable gross weights. Engines of 250 hp will be adequate and all that can be safely used with available chassis components in the middle and eastern two-thirds of the country. Beyond the Rockies, a few 300-hp engines have been used but the demand for such power decreases daily because such engines are relatively uneconomical. An added 50 to 100 hp could be put to good use if it entailed no greater size or weight and no loss of economy.

Ten years from now things may be different. Highways may make more power unnecessary. When you have overcome rolling resistance and air

resistance, and have balanced out the internal friction of the chassis, a 50,000-lb gvw rig, traveling 60 mph on a good level road, has used about 200 hp. Any additional power is useful only for acceleration and grades.

We don't anticipate materially higher speeds than the present maximum permissible 60 mph on toll highways. Running time gains at higher speeds, say 70 mph, are disappointing. And higher speeds are risky no matter how much brakes are improved.

If the gas turbine can measure up to today's standards of best equipment—100,000 to 200,000 miles between overhauls and a maximum yearly downtime of 10 days—and develops no unforseen drawbacks of any kind, it is bound to replace the piston type engine in time. But unless it can measure up in all particulars, especially in economy, it hasn't a chance.

(Paper "The Requirements of the Fleet Operator for Future Powerplants" was presented at SAE Mohawk-Hudson Section, Latham, N. Y., Dec. 14, 1954. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Synthetics Replacing Natural Rubber

Based on paper by

J. J. ALLEN
Industrial Products Division
Firestone Tire and Rubber Co.

THE need for a rubber-like material that could withstand high temperatures, aging, and oil corrosion encouraged the development of synthetic rubbers. In 1930, Thiokol was introduced. It has excellent oil and solvent resistance but has relatively low tensile strength, low resilience, and is thermoplastic.

Neoprene, introduced in 1932, resists oils, sunlight, ozone, oxidation, and heat. It has resilience almost as good as natural rubber.

Buna-N, which originated in Germany in 1939, resists oil, gasoline, and aromatic solvents. Since it has relatively good heat resisting characteristics it is used primarily for all types of oil seals.

GRS is the general purpose synthetic rubber selected by the government for bulk production during World War II. Its properties approach natural rubber more nearly than any other synthetic. Although resilience is only fair, it resists abrasion, heat aging, and water absorption, when suitably compounded.

Butyl rubber is outstanding in its chemical resistance and low permeability to gasses. It resists deterioration by weather, sunlight, oxygen, and ozone, and shows little change in hardness with heat aging.

For abnormal temperatures the new silicone rubbers and polyacrylate rubber compounds have been developed in recent years.

Demands are still being made for rubber products to function under even more severe conditions than before, particularly for higher and lower temperatures and with new lubricating and transmission oils.

(Paper "Natural and Synthetic Rubber in the Automotive Industry," was presented at the SAE Golden Anniversary Passenger Car, Body, and Materials Meeting, Detroit, March 1, 1955. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Static Testing Needs Backing of Experience

Based on papers by

OBED WELLS
Cessna Aircraft Co.

and

C. H. PREWITT
Beech Aircraft Corp.

THE testing program gets underway at Cessna as soon as the first of each component is complete. Normally, we consider the empennage first, then follow with the wing and fuselage, control system, and miscellaneous tests.

The empennage and other control surfaces are small enough to permit use of shot bags for loading. The surfaces are supported on a jig and a supporting cradle holds them while the shot is applied. The support is then released so that the surfaces are free to deflect.

We expect the wing to carry between 85 and 105% of design load for the most critical condition so we start testing with the least severe condition and progress until the most critical one is reached. An additional 15% factor is carried which we call the "growth" factor. On all of the less critical conditions loading will be stopped at +115% of design load, but on final or more severe conditions, the load will be carried to destruction.

By outlining the order of tests properly we are able to do practically all testing with one static test component instead of two or three and thus keep testing cost to a minimum.

The same basic philosophy is followed with the fuselage. The least severe conditions are tested first up to 115% design load and the most critical conditions last to 115% and on to destruction. In testing the fuselage we combine various conditions in an attempt to simplify as well as economize

and still prove the structure satisfactorily.

Recently we have used a recording oscillograph and accelerometer in landing gear drop tests and find that this gives an accurate load factor while eliminating a great deal of time previously required in plotting the space-time curve.

Over the years, Beech has used a combination of stress analysis and static test to obtain approval. The completeness of the stress analysis depends upon a number of factors, principally the availability of manpower and whether or not the design is new or radical. One practice has been to (1) write a rather complete load analysis, (2) write a stress analysis only for landing gears, castings, fittings and their vicinity, and spar caps, and (3) obtain approval entirely by static test.

The sequence and manner of testing depends in some degree on delivery dates of the static test components. Usually the order is: tail surfaces, engine mounts, fuselage, control systems and surfaces, and wing and fuselage. Miscellaneous tests such as seats, floor structure, castings, and landing gear doors, are conducted at opportune times. Total test conditions number nearly 100. Most tests are conducted to 120% to allow for growth in later years, with the most critical conditions being tested to failure.

Well balanced, efficient structural design comes only from a good basic structural arrangement. The burden of good structural design falls primarily on the designer rather than on the stress engineer, who must follow but cannot lead.

The static test engineer must go beyond application of test loads and set up standards of acceptability based upon his accumulated experience, striving always to correlate his testing techniques and data with field service experience.

The stress analyst must strive to provide a thoroughly safe and well balanced design. He should make every effort to remove material from secondary and non-structural members, allowing them to be justified by static test, yet provide sufficient material for a thoroughly reliable, consistent, and efficient primary flight structure that will stand the test of time. Entirely too much effort can be spent in justifying extremely high stresses in a few critical regions and not enough in eliminating weight in numerous low stress regions.

(Paper "Structural Design and Static Testing of Utility Aircraft" was presented at SAE Wichita Section, Nov. 12, 1954. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Similar Accidents Should Never Recur

Based on paper by

L. J. BORDELON

Convair Division, General Dynamics Corp.

ACCIDENT reports afford one of the most prolific sources of safety design data, but their value depends wholly on the investigator's competence in reporting. Definite, glittering gems of fact must be sought out if results are to benefit engineers. And one way to present facts beneficially is to use a safety design checklist.

The checklist is designed to aid the designer in considering points of vulnerability to his particular specialty. Specific instances are sifted from basic data and reduced to short, poignant statements as to what happened. These are arranged under appropriate headings for ready reference. The list says in effect: "This particular thing happened before. Can it happen to your design?" or, positively: "This costly experience was gained in this manner and was solved this way. Can you use this experience in your design?"

The checklist promises to be an effective tool. It brings up remote relationships, which have given trouble in the past, so that they may be considered in relationship to a particular design. It is often the elusive, remote relationships which have escaped attention that sooner or later are exposed as the basic or contributive cause of accident.

A case in point occurred with the Convair-Liner. In this airplane the fuel is carried outboard of the engine nacelles. The cross-feed line is the only point where fuel is present in the fuselage area.

Early in the design period, it was questioned whether to use mechanical or electrical shut-off valves and the former were chosen as safest. However, it happened that one airplane was subjected to a landing impact so hard that it caused the wing to shift at the root which caused the cable actuated valve to open. Fuel was discharged, fire broke out, and although there were no casualties, the plane was destroyed. After that, electrically operated shut-off valves were

installed, and although even more severe impacts have been sustained, there have been no fires.

Failure to detect the possibility of such a chain of events is not the point. The moral is that having suffered the experience, all future designs should be considered vulnerable to this condition.

And a further moral lies in the interchange of safety information among us. There is no more practical approach to the safety problem than to utilize industry-wide experience. Free interchange of safety information is essential.

(Paper "Safety Considerations in Aircraft Design" was presented at SAE Golden Anniversary Aeronautic Meeting, New York, April 18, 1955. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Based on Discussion . . .

William C. Lawrence, American Airlines, Inc., declared that mistakes are repeated on model after model and that it is high time for manufacturers to face up to this problem. Safety, he said, arises from a state of mind. Everybody connected with design must be safety-minded—not just the experts. He pleaded for simplicity and for the avoidance of compounding difficulties so that one fault leads to another.

Jerome Lederer, Flight Safety Foundation, remarked that while the checklist was a valuable device, we must not lose sight of the absolute necessity for imagination and thought in each design.

Hydra-Matic Family Covers Extensive Range of Trucks

Based on paper by

W. W. EDWARDS

GMC Truck & Coach Division, General Motors Corp.

HYDRA-MATIC is not one specific transmission unit. It's really a principle of design and operation which has been adapted to a variety of operations. The various Hydra-Matic units now on the road each are engineered to engine power. They adjust themselves to take care of changes in road and load conditions.

The truck version of Hydra-Matic appears in three different power train arrangements:

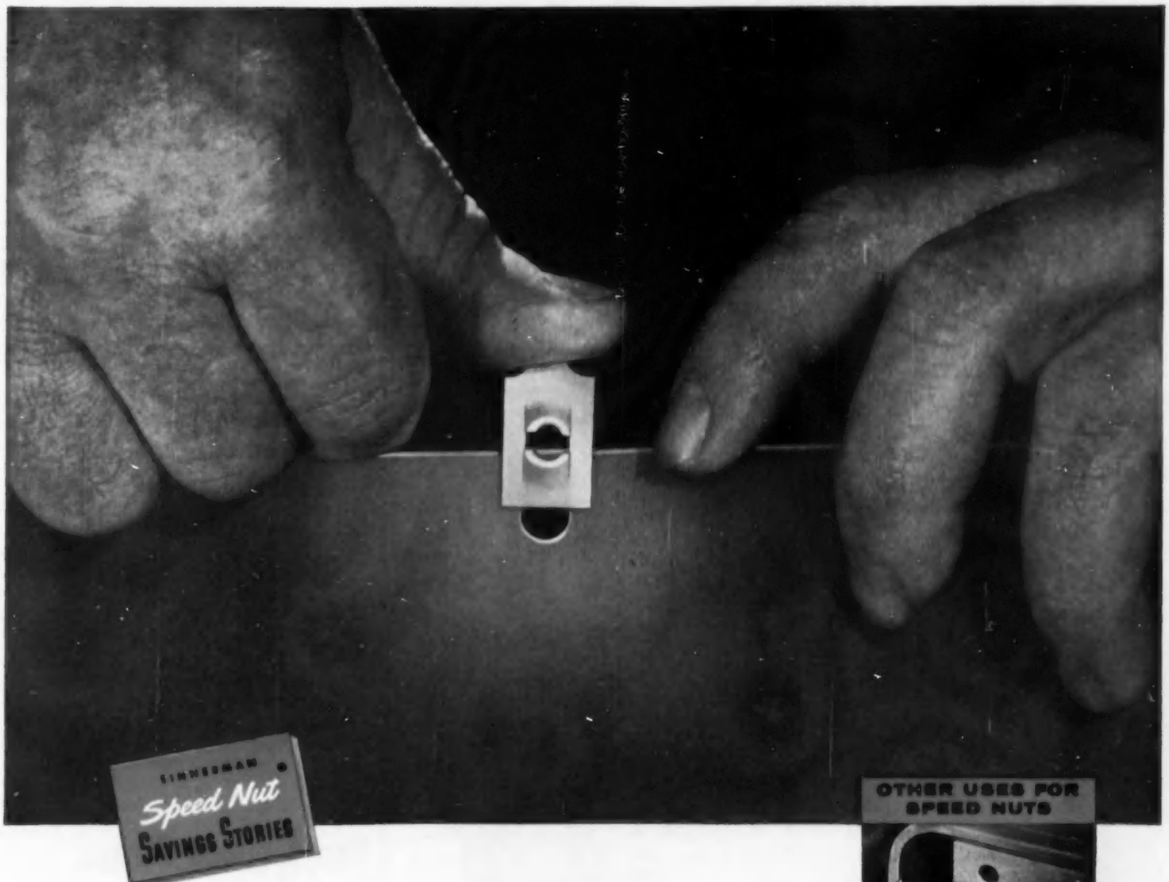
1. The four-speed Hydra-Matic is used in vehicles up to 16,000 lb GVW for light-duty service.

2. The four-speed Hydra-Matic is combined with a two- or three-speed reduction unit in vehicles from 16,000 lb GVW to 60,000 lb GCW.

3. Twin Hydra-Matic with a two- or three-speed reduction unit is used in vehicles ranging from 29,000 lb GVW to 70,000 lb GCW.

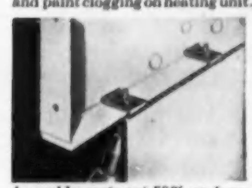
The Twin Hydra-Matic consists of two heavy-duty four-speed Hydra-Matics, one mounted above the other and geared together at the front and rear. The gearing at the rear gives a speed differential of about 25% between the upper and lower units.

Since each Hydra-Matic unit has its own valve body and governor, the upper and lower units shift alternately and independently. For example, on the diesel engine the lower unit shifts



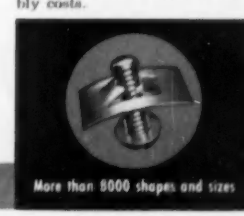
OTHER USES FOR SPEED NUTS

"J" type Speed Nuts eliminate problems of hole misalignment and paint clogging on heating unit.



Assembly costs cut 50% on farm equipment with "J" type Speed Nuts.

"J" type Speed Nuts help plastic sign maker save 48% in assembly costs.



Thumb Replaces Spot Welder with Tinnerman SPEED NUTS!

Here is a typical assembly-line scene . . . a Tinnerman "J" type Speed Nut being applied to a panel where a weld-type fastener was formerly used. That's the way to cut assembly costs—by saving precious man-hours and eliminating the need for special skills, tooling and equipment!

This one-piece, self-locking, spring steel Speed Nut brand fastener not only makes welding unnecessary, but it also eliminates clinching, staking, tapping, and costly threaded inserts. It snaps in place by hand quickly, easily, and provides a heavy-duty vibration-proof attachment. Self-retained in screw-receiving position, it is ideal for blind-location assembly.

"J" type Speed Nuts are available for a full range of screw sizes and panel thicknesses. In all, there are more than 8000 variations of Speed Nut brand fasteners to help you reduce assembly costs. See your Tinnerman representative soon . . . and write for your copy of Speed Nut "Savings Stories."

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first, then the upper unit. This feature provides seven forward speeds.

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When the chassis is lubricated, you should:

1. Check fluid level.
2. Check for fluid leaks.
3. Check adjustment of front bands.
4. Check solenoid operation.

Every 15,000 miles, you should:

5. Change oil.
6. Check transmission oil pressure.
7. Check transmission linkage.

(Paper "Hydra-Matic Transmission Trucking" was presented at SAE Metropolitan Section, New York, May 5, 1955, and at SAE Chicago Section, Nov. 16, 1954. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

New Engines Stress Interchangeability

Based on paper by

WILLIAM A. WISEMAN

Continental Motors Corp.

IN designing a new series of engines for utility aircraft which would have greater installation flexibility and improved output and fuel economy, cylinder spacing and size were left unchanged to gain machine tool interchangeability. It then developed that the engines would be shorter and flatter than previous ones of the same displacement.

The short engine configuration posed one of the major problems in the design of the starter mechanism. Several designs were discarded because of cost considerations, weight, complexity, or an excess of moving parts. The design selected was placed at right angles to the crankshaft, parallel and adjacent to the right rear cylinder. Operation involves a worm gear and wheel with 24:1 ratio driving a wrapping type of helical coil spring. A further reduction of 2:1 between starter shaft gear and crankshaft gear gives a total reduction from starter motor to crankshaft of 48:1. This gives adequate torque multiplication for cranking without an expensive heavy-duty starter motor.

(Paper "A Systematic Series of En-

gines for Utility Aircraft" was presented at SAE Wichita Section, Nov. 12, 1954. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Canada Has Shortage Of Aircraft Engineers

Based on paper by

AIR MARSHALL W. A. CURTIS

A. V. Roe Canada, Ltd.

CANADA has over 60,000 employed in its aircraft industry. This compares with a peak of 80,000 in World War II. Two jet engines have been designed. More than 1500 of one of them, the Orenda, have been produced. What's more, whole aircraft are being designed and built to meet Canadian needs.

At the moment the industry faces a shortage of engineers. The present position of the industry was made possible by getting experienced men to emigrate from the United Kingdom, plus a few from the States. This source has pretty well dried up. The United States has been recruiting aeronautical engineers in Canada, and Avro Aircraft, Ltd. has been doing the same in the United States. Anyway, rentals of this nature are a temporary measure. Canada must train her own young engineers.

(Paper "The Aircraft Industry in Canada" was presented at SAE Canadian Section, Toronto, Jan. 19, 1955. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

No One Turbine Fuel Has the Edge on Safety

Based on paper by

H. E. ALQUIST

and

R. M. SCHIRMER

Phillips Petroleum Co.

HEART-CUT JP-4, roughly the hydrocarbons boiling between 250 and 400 F, is the best overall performance compromise turbine fuel. But whether it will be economical to use it in pref-

erence to aviation grade kerosene in the future remains indeterminate.

This heart-cut fuel has many advantages. It would:

1. Meet low freezing point requirements readily.

2. Avoid the weight penalty of kerosene or heavier fuels.

3. Be superior to kerosene in combustion.

4. Probably be equivilent to kerosene in respect to minimum variations on fuel supplied throughout an airline route.

A flash point above 60 F and a Reid vapor pressure below 0.5 lb may indicate a slight increase in ground handling hazard in contrast to aviation kerosene, but there seems to be no universal agreement that there is a substantial difference in overall safety even between JP-4 and kerosene.

The 250–400 F boiling range material is used in motor fuel or as feed stock by refinery reformers and platformer facilities. If used as an aviation fuel it would become competitive and this has bearing on its availability. However, any middle distillate selected for airline use will have one or more competitive applications.

(Paper "A Critical Survey of Commercial Turbine Fuels" was presented at SAE Golden Anniversary Aeronautic Meeting, New York, April 20, 1955. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Research Pushes High Lift Systems

Based on paper by

JOHN S. ATTINELLO

Bureau of Aeronautics, Navy Department

CAPTURED German documents tell of boundary layer control systems being developed and applied to five different aircraft. The most promising of these installations appears to be the Arado 232, which has been studied and applied in altered form to a Cessna 170 by the Cessna Company under ONR and BuAer sponsorship.

The Cessna 309, as it is now called, showed take-off reductions of 40%, the stall speed being some 15 mph slower than the 170 model. The mechanism weighed some 350 lb for a machine of approximately 2000 lb gross weight, but a reduction is believed possible.

More recently another system, based on a French design which uses the main jet engine as a pumping source, has been applied to an F9F-4 Navy jet fighter by the Grumman Aircraft Co., under a BuAer contract and with the cooperation of the Allison Engine Division of General Motors.

The lift increase on this Panther made possible by the new system was equivalent to a 25% increase in wing area. The weight penalty of the installation was 50 lb. This 50-lb increase in lifting effectiveness would permit carrying more than 3000 lb of additional payload at the same take-off speed. The BuAer Supercirculation system is not a panacea for all ills and it is not directly applicable to all existing aircraft, but it is a step in the right direction. (Paper "Wing Lift Augmentation Methods for the Improvement of the Low Speed Performance of High Speed Aircraft" was presented at SAE Golden Anniversary Aeronautic Meeting, New York, April 20, 1955. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Based on Discussion . . .

David Hazen,

Princeton University

The selection of the system will be greatly influenced by the end result desired and the type of aircraft considered. Therefore, a warning is in order against the tendency to extend the application of any boundary layer control (BLC) system to the entire range of aircraft.

We should not fall into the trap of comparing BLC system effectiveness solely on the increment of lift produced since, in the final analysis, the airplane responds to its lift-drag polar. Great care is needed to tailor spanwise load distributions in order to maintain the spanwise efficiency factor at a value sufficient to avoid creating large lift coefficients, without sufficient power to maintain level flight under these conditions.

Leo A. Geyer,

Grumman Aircraft Engineering Corp.

The F9F-4 was a "natural" for this BLC installation. The weight number of 50 lb is most attractive but could be cause for over-optimism. If similar systems are applied to more modern jet aircraft equipped with thinner

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wings and with higher thrust engines giving higher bleed-air temperatures and pressures, the weight penalty can be four or five times this number.

R. L. McManus,
General Electric Co.

Do we implement the BLC concept with a blowing, suction, or compound system? Until this question has been answered, two important members of the implementation team—the engine manufacturer and accessory manufacturer—are left out. The engine producer isn't going to design high bleed flows into the new engines; the accessory manufacturer isn't going to develop a high capacity auxiliary powerplant unit. Let's somehow reduce present knowledge to a most needed common denominator so that the sharp progress curve of BLC will continue upward.

Kenneth Razak,
Dean of the School of Engineering, University of Wichita

The use of direct engine bleed has been found to be a practical approach to BLC in spite of power for pumping being many times greater than that required with other methods. Any device which would reduce power requirement would add so much weight and complexity to the system as to make it almost impractical. Research is now being carried on to reduce the amount of bleed air for a given lift increment and thus make the system more practical.

Estimated Effects Critical for Airlines

Based on paper by

W. G. LUNDQUIST
Wright Aeronautical Division, Curtiss-Wright Corp.

IN a period of powerplant transition we should look for engine factors which can take as much guesswork as possible out of the estimated effects. This can be done. Here are suggestions for its accomplishment:

1. The civil engine should be substantially "derated" temperature-wise compared to its maximum developed capability. This should be done for safety and durability. Weight and performance will be penalized to some degree, but these are predictable effects. The effect of erratic reliability is unpredictable and can be catastrophic for an airline.

2. The civil engine should be as "fail safe" as possible, even at the sacrifice

of considerable performance. This is different from durability and it can be very serious if overlooked.

3. Provisions should be made to meet the foreign object damage problem. There are procedures and devices to help, but they may penalize performance or weight. Neglect of this problem could effectively ruin scheduled operations.

4. Provision should be made for adequate anti-icing.

5. Power controls must be reliable.

(Paper "Aircraft Powerplants—Present and Future" was presented at SAE Golden Anniversary Aeronautic Meeting, New York, April 18, 1955. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Aircraft Accessories Create Design Problem

Based on panel report by

E. C. SULZMAN

Jack & Heintz, Inc.

THE problem of powering aircraft accessories has become crucial. This is recognized by all concerned, but engine manufacturers, accessory builders, and the producers of airplanes have not agreed on a solution.

The Navy has queried aircraft manufacturers to determine their preference regarding accessory drives. It found them favoring direct mounting on the engine. Engine builders, on the other hand, appear to lean toward a power take-off drive operating a remote-driven gearbox.

Aircraft builders believe that an integrated system which is coupled directly to the engine can save weight and space. They declare that remote gearboxes are mechanical problems, while air bleed systems are low in efficiency. Engine builders favor the power take-off drive to keep the engine frontal area to a minimum and to avoid the compromises and inflexibility which, they say, results when all necessary drives are built into the basic engine.

One manufacturer who favors power take-off drives has found that additional drives, specified as time goes on, end in an engine configuration overgrown with gearboxes. As a result, consideration is being given to incorporating a constant-speed drive integral with the engines for the driving of a-c generators.

Those concerned are in pretty gen-

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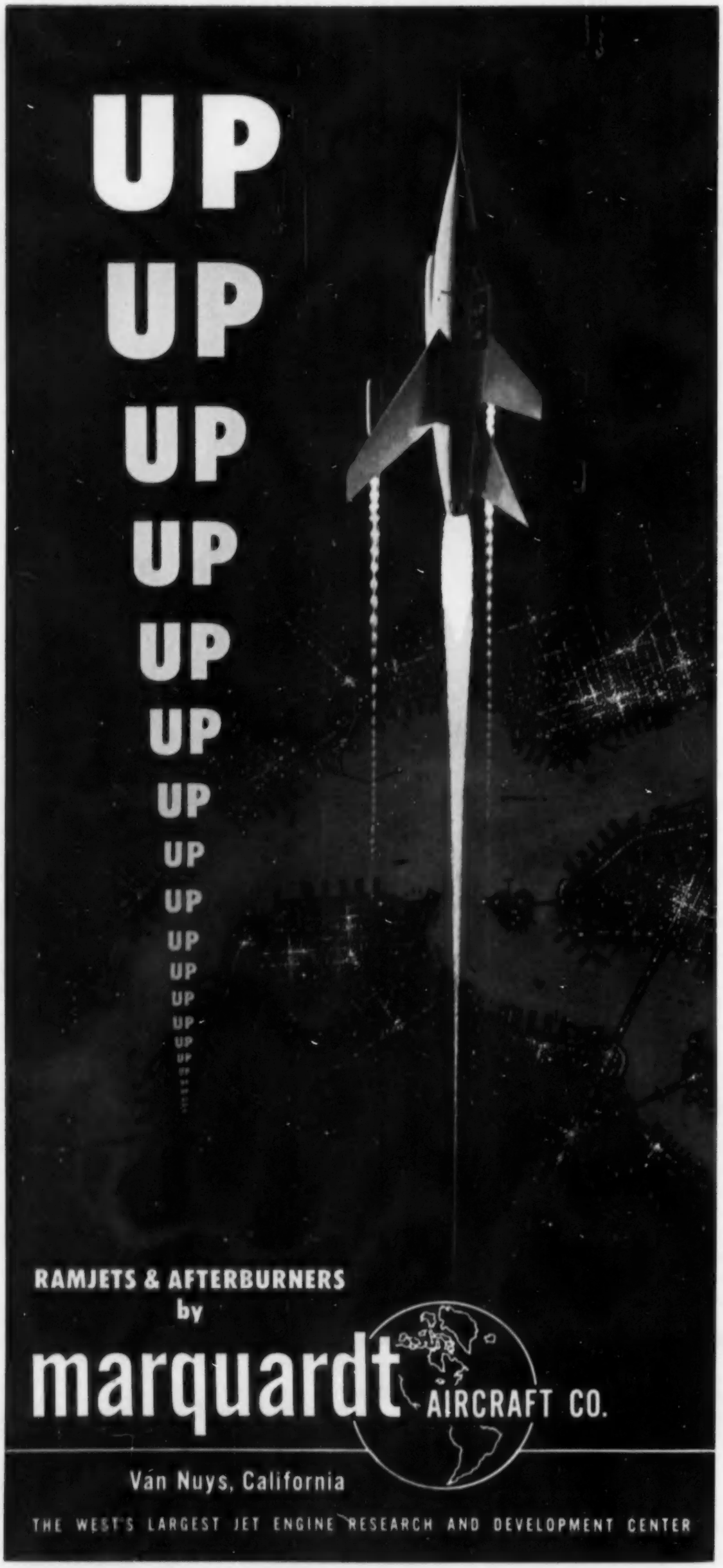

eral agreement that all aircraft system requirements should be analyzed in the early stages of airplane design because accessory application can be a controlling factor in that design.

Apropos of this, the Navy is trying to plan for such requirements for five years in advance and is seeing to it that engine, aircraft, and accessory builders hold joint meetings with the Bureau of Aeronautics on all Navy aircraft designs. The Air Force is seeking guidance from the Aircraft Electrical Advisory Staff concerning future requirements. With this information they try to guide the engine companies to get the necessary provisions for driving accessories.

The trend toward system analysis should improve the situation. Nevertheless, as one engine producer puts it, it takes a minimum of five years to develop an engine and it is difficult to foresee accessory requirements five years in advance.

(This article is based on the secretary's report of Panel on Accessory Power Source held as part of the Aeronautic Production Forum at the SAE National Aeronautic Meeting, New York, April 18, 1955.)

Serving on the Accessory Power Source Panel were . . .

Panel Chairman:

George Sherman
Wright Air Development Center

Panel Co-Chairman and Secretary:

E. C. Sulzman
Jack & Heintz, Inc.

Panel Members:

T. E. Abraham
Douglas Aircraft Co., Inc.

George R. Greene
Wright Air Development Center

E. F. Heaton
Wright Aeronautical Corp.

Karl Martinez
Boeing Airplane Co.

Robert Shafer
Bureau of Aeronautics

G. P. Townsend
Westinghouse Electric Corp.


the UP and UP story on the
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These simplified, compact pumps have an outstanding record for performance and dependability—assure users of long trouble-free service and low maintenance expense. No wonder production of American Bosch PSB pumps goes UP and UP month after month to meet the demand. American Bosch, Springfield 7, Massachusetts.
AMERICAN BOSCH
Division of
American Bosch Arma Corporation

Hudson-Nash Merger Saves Tooling Millions

Based on paper by

E. L. MONSON

Kenosha Division, American Motors Corp.

THE merger of Hudson and Nash into American Motors Corp. has resulted in a savings of over 15 million dollars in design, tooling, and use of equipment on the first year's models. This is based on the estimate that if Hudson and Nash had continued independently, total cost of tooling for the present line of cars would have been 25 million dollars. The job was done with an expenditure of 9.5 million.

These savings were accomplished mainly by standardizing parts and body design so that the various Hudson and Nash models could be assembled on the same line. For instance, Hudson had been using a one piece cast iron clutch housing for the manual shift transmission and a two piece cast iron bell housing for the automatic transmission. All were purchased from outside foundries. Nash had a one piece cast iron housing made in a company foundry. By adding a few bosses and making a few other minor revisions in the pattern equipment, a common casting was produced in the Nash foundry for both models.

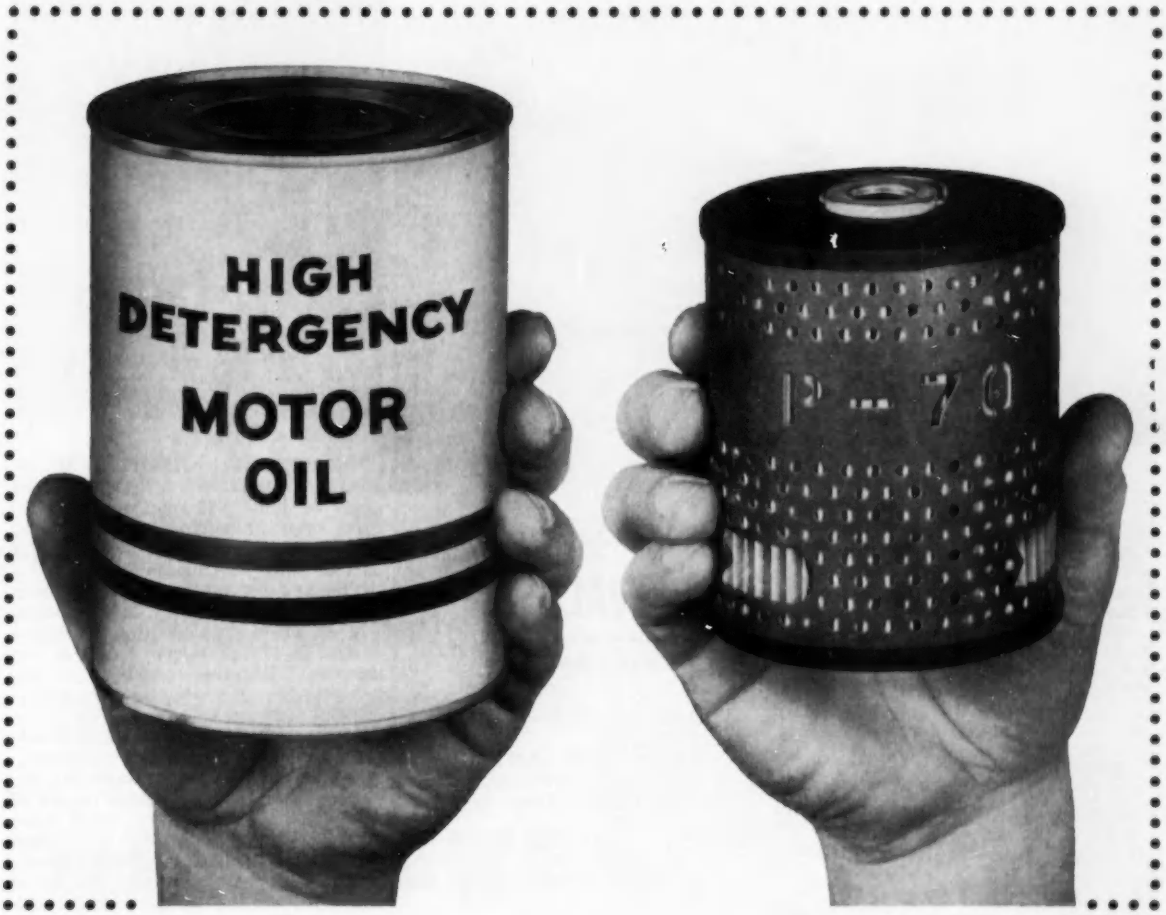
For cars equipped with automatic transmissions, Nash had a permanent mold die casting which had been developed to cut down machining time and weight. This die casting had been used in the 1954 models. After the merger, the mold equipment likewise was revised with minor modifications and the casting is now used on both the Hornet and the Ambassador reducing weight and machining time.

Other components that were standardized were engine mounts, rear axle and rear suspension, torque tubes and propeller shafts, engine support crossmembers, radiator cores, clutch and brake operating mechanisms, and the wrap-around windshield.

The wrap-around windshield presented many problems. The Nash unitized body construction, in which the frame and body are an integral welded unit, can be compared to a bridge with steel super structure to give it minimum vertical beam deflection and maximum torsional stiffness. If you were to remove the end diagonal members of the superstructure, the bridge would probably collapse. The diagonal front door post in our unitized bodies, extending from the body sill to the roof is as important as the end diagonals of a bridge. Putting a "dog leg" in these posts to permit the wrap-around windshield design, would be almost as bad as removing it completely. Unitized bodies have always had less vertical deflection and more torsional stiffness than most cars with separate frames and bolted-on bodies. This standard of rigidity had to be maintained.

We took one of our existing cars which had a conventional windshield and carefully measured the deflection and stiffness by our standard test procedure. The door posts were cut out of the cowl to the roof. Then from sketches supplied by our body design group, "dog leg" posts were fabricated and welded in. As was expected, we lost some rigidity. But after some weeks of effort we came up with a structure with greater rigidity than before. This was accomplished by redesigning the body main sills, adding a pair of sub sills extending from a point approximately in line with the dash to the back of the front seat, and locating the sill reinforcements strategically.

(Paper "American Motor's First Year" was presented at SAE Milwaukee Section Meeting, in Kenosha, Wisconsin, May 6, 1955.)



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News About Special Publications

• • • • •

ENGINEERING KNOW-HOW IN ENGINE DESIGN (PART 3) just made its debut. If your work touches upon internal combustion engines in any way, you'll want to make this a part of your working library.

The new volume is in the tradition of the first two parts in the series . . . an up-to-date treatise on engine design as it's practiced today in the industry. Leading specialists in the field have contributed to this seven-section treatise to make it a living reference work on fundamentals rather than an academic textbook.

It deals with engine materials, reciprocating engine dynamics, design of an opposed piston diesel, light two-cycle engines, combustion chamber shape, and gasoline and diesel fuels.

This new publication is a product of the third annual lecture series sponsored by the SAE Milwaukee Section. The price is $3.00 to members, $6.00 to nonmembers.

• • • • •

Looking for the latest information on your automotive engineering specialty? The new SAE checklist of papers and publications will prove a big help. It's yours just for the asking . . from SAE Special Publications Department. It covers all available SAE papers (presented at both National and Section meetings) during the first half of this year.

• • • • •

JET TRANSPORTS are preempting the aviation headlines these days. The Vickers Viscount now operating in Canada, and soon to be in operation in this country, and American Airlines' order of Lockheed turboprop airliners have stirred up excitement in aeronautic circles.

The story behind the headlines and the news is brought to you in the SAE symposium "What's Ahead in Engineering for Jet Transports." The eight papers in this collection give a straight-from-the-shoulder view of jet transport problems and aspirations as seen by the airlines operators, engine builders, airframe manufacturers, and petroleum technologists. Price of the package is $2.50 to members, $5.00 to nonmembers.

New Members Qualified

These applicants qualified for admission to the Society between May 10, 1955 and June 10, 1955. Grades of membership are: (M) Member; (A) Associate; (J) Junior.

Atlanta Section

William Richard Harper (A), James G. Sloan (A), Harvey Q. Strother (A), J. L. Wimbish (A).

Baltimore Section

Albert A. Kauslick (J).

British Columbia Section

Gordon Stanley Boyle (J), Neville Mitchell (M).

Buffalo Section

Glenn J. Austin (M), George Joseph Persico (A).

Canadian Section

William L. Bentley (M), Keith J. Warren (A).

Central Illinois Section

Arthur D. Gay (J), Rudolph K. Polak (M).

Chicago Section

Walter E. Arens (M), Richard D. Costley (J), Howard A. Heckendorf (M), A. King McCord (M), Leo F. Sauter (A), P. A. Taillefer (M), Paul M. Uitti (J), Walter W. Whitlock (A).

Cincinnati Section

Lee L. Bushong (M), Wray D. Simpson (M), Charles H. Sitterly (M), James D. Stevenson (M).

Cleveland Section

Richard Bicknell (J), Edward G. Dingman (J), Cecil L. Hunter (M), William Tebbel (A), Robert Clayton Wattleworth (J).

Colorado Group

Orie J. Stemen (M).

Dayton Section

Thomas F. Davidson (J).

Detroit Section

Joseph L. B. Bennett (M), Robert C. Brady (J), Francis M. Coffey, Jr. (M), Mortimer C. Crockett (A), Elias T. Diehl (M), George S. Ellis (M), Frank J. Esser (J), Royce E. Everett (J), Thomas J. Fairhurst (A), Melvin M. Gerson (M), Ralph E. Glahn (M), Prescott L. Goud (M), Donald G. Harter (M), William A. Hermonat (M), Russell W. Hunter (M), James R. Johnson (J), George E. Kelm (M), Keith Franklin Knorr (J), Sydney E. Leese (M), James F. Leland (M), Robert F. McLean (M), James C. Miller (J), Henry Ernest John Pringham (M), William O. Robbins (M), Jesse A. Robison (M), Ambrose J. Rock (M),

New Members Qualified

continued

Peter S. Saigh (A), Eric B. Saward (M), William L. Scudder (J), Frank Whitney Szanto (J), Harry R. Wolf (M).

Indiana Section

Leland E. Boren (M), Max Gene Clingerman (J), Edward R. Hansz (M), Roy H. Werking (A).

Kansas City Section

Earl Wesley Roark (A).

Metropolitan Section

John H. Brewer (M), Anthony C. Degutis (A), Howell K. Fesq (M), Edwin L. Frost (J), Park Wheeler Judah (M), Herschell W. Kelley (M), William E. Lifson (M), Matthew J. Pastell (J), Paul E. Peacock, Jr. (M), C. Anthony Ranieri (M), Harold L. Rounds (J), Arthur W. Stewart (M).

Mid-Continent Section

O. N. Thomas Fleig (M), William H. Hall (M), William P. Hannan (M), James E. McClelland, Jr. (M), John W. Riley (M).

Mid-Michigan Section

John E. Kersten (J).

Milwaukee Section

Joseph J. Birkenstock (M), William F. Danner (M), R. L. Jaeschke (M), Gene E. Maeckel (J).

Mohawk-Hudson Section

Chace R. Sherman (M).

Montreal Section

Roland Dery (J), Desmond James (M), Ben Merson (A), Joseph Jean-Paul Meunier (J), William Sillar (M).

New England Section

Frank Doubek (M), Lewis H. Roosa (J), Hatherley A. Stoddard, Jr. (M).

Northern California Section

Frank Hijos, Jr. (A), Kenneth Krohncke (A).

Oregon Section

Stephen E. Wright (A).

San Diego Section

F. Daniel Applegate (M), Clarence A. Gerber (M), Robert H. Manley (A), Lewis K. Pratt (M).

Southern California Section

Raymond Clarence Brown (J), Charles S. Glasgow, Jr. (M), Harold E. Herdrich (M), Bernard L. Rice (A), Frank A. Routa (A).

Southern New England Section

Donald L. McCollum, Jr. (M).

Texas Section

Milton Green (M), J. W. Larson (M), Arthur J. Smith (M).

Texas Gulf Coast Section

John C. Davis (A).

Twin City Section

Sigurd A. Rishovd (M), Willis S. Zeigler, Jr. (J).

Virginia Section

John W. Watkins (A).

Washington Section

Wilbur P. Lamb (A), Herman P. Simon (M).

Outside Section Territory

Ira J. Barber (M), Richard C. Brown (J), Vincent F. Burke (A), George

John Hannes (A), Joseph R. Lejk (J), Stanley David Liedtke (M), Robert Henry Miller (J), Otto Reymer, Jr. (A), Thomas A. White (A).

Foreign

Dr. Ferruccio Accardi (M), Italy; Charles Apert (M), France; Oswald E. Boll (A), Switzerland; Donald McGregor Clark (M), So. Africa; Richard Bernard Ibanez (J), Saudi Arabia; P. H. Ramaswami (J), So. India; John A. Simms (M), England; Charles Gerald Tresidder (M), England; George Collins Wade (M), Australia.

Applications Received

The applications for membership received between May 10, 1955 and June 10, 1955 are listed below.

Alberta Group

Andrew W. Peterson.

Baltimore Section

Gerald E. Lutz, John T. McFarland, Jr., R. James Pfeiffer, Donald Resch, Frederick Topolsky.

Buffalo Section

Harry S. Jakubowski.

Canadian Section

Burton A. Avery, Albert E. Collins, William P. Gent, Karol J. M. Godlewski, Stanley C. Goodwin, Nevil J. Newbold, Robert S. Norminton.

Central Illinois Section

Jack E. Fair, Donald M. Horning, E. W. Lapp, Richard W. Luttrell, Robert E. Woodcock.

Chicago Section

Chris Andros, Dwight L. Barr, Donald R. Brincka, Norris E. Caudell, Wallace J. Costenaro, Harris E. Dark, Arthur E. Evenson, Edward J. Mateja, John W. Moules, Carl J. Oldenburg, Edward G. Orth, Paul E. Pfeifer, LeRoy W. Randt, Vincent P. Reilly, Martin G. Sachs, Walter E. Sargent, Murray D. Scott, John E. Tudor, William R. Walker.

Cincinnati Section

George E. Grega, Jack E. Koch.

Cleveland Section

Julius Barat, Ralph J. Bernotas, William H. Denton, Mario A. DiFederico, Walter J. Fifer, Charles J. Gervason, Michael J. Halaiko, George V. B. Hall, J. Robert Jameson, George A. Kling, Robert B. Miller, James T. Morrison, Allison C. Neff, Jr., Logan Ross, Albert Saltsman, Jr., Ray J. Stanish, Frank G. Steinebach.

Applications Received

continued

Colorado Group

Richard R. Riss, II, David D. Ruehlman, Jr.

Dayton Section

Major Preston Cornett.

Detroit Section

William E. Adams, Budd N. Barclay, Roger C. Bascom, Jr., Robert A. Carley, James E. Colbert, James T. Congelliere, Joseph A. Drankowski, Joseph P. Eastman, Norman W. Faustyn, Richard A. Gustafson, C. O. Jackson, Jr., John D. Lewis, Alastair S. MacLennan, Willard A. Murray, Carl B. Pfeiffer, Hendryk R. Piecura, Marcel R. Raveschot, Robert W. Sanderson, Albert Sniderman, Oliver P. Swope, Jr., Kelly W. Thurston, Victor S. Warren, Warren D. Wolcott, Richard H. Zeder, John F. Zerbey, III, Henry Zeuner, Leon Zontek.

Hawaii Section

Lewis W. Erwin, Edwin K. Stearns.

Indiana Section

Charley E. Benqtsson, Thomas F. Bernhardt, William G. Cichowski, Marshall F. Reehling.

Kansas City Section

Robert A. Kilgore, Sidney C. Palmer, James W. Weldon.

Metropolitan Section

Irving T. Bartlett, Jr., Charles E. Bodemann, Jr., Michael J. Carbotti, Vincent Cerullo, Walter R. Haldeman, Alfred J. Kinn, Edward E. Law, Fred E. Nelson, Jack S. Rubin, Robert A. Schmicker, Joseph Scianna, Jack Simon, Elwin E. Smith, Richard A. Sorenson.

Mid-Continent Section

George D. McLean.

Mid-Michigan Section

Robert J. Johnson.

Milwaukee Section

Kenneth L. Morgan, Ronald E. Lewis, George Eric Otto, Robert E. Rohde, Frederick E. Suhm.

Montreal Section

Philip Baxter, Marcel Beaumier, Percy R. Dowden, Charles F. Russell, Charles M. Thomson, William O. Will.

New England Section

John A. Bowler, Hyman Cohen, William Jeuick.

Northern California Section

Vincent Villasenor.

Northwest Section

Fred H. Heiberg.

Philadelphia Section

E. N. Alexander, Frank E. Anderson.

Pittsburgh Section

Robert C. Eazor, Ludwick J. Perman.

Salt Lake Group

John C. Bates.

San Diego Section

Ralph L. Bayless, John T. Pertile.

Southern California Section

Leo M. Blom, Jr., Robert D. Brown, Edwin H. Charles, Jack E. Henry, Saul Mandel, Paul A. McDonald, William H. Moffat, Henry Rust, Jr., Harold W. Seyle, William L. Sparks, Edward Woo, Seymour P. Zeldin.

Southern New England Section

Willard W. Bunnell, Mark Goedecke, Edward V. Huda, James H. Patrie.

Spokane-Intermountain Section

Carl O. Tangen.

Texas Gulf Coast Section

Robert E. Engelhardt, Herbert P. Ferris.

Texas Section

Frank J. Carlson, George Sadek, Al C. White, David K. Wood, Birdell F. Grossman.

Twin City Section

Harry T. Bratt, Theodore A. Sundin, Glen J. Tobias.

Washington Section

George G. Richey, Carl C. Sorgen.

Williamsport Group

Jerome L. Lorenz.

Outside of Section Territory

Robert L. Allen, W. E. Clements, Carlos Gallegos, Richard V. Gidner, Henry D. Kadavy, Glen B. Sorensen.

Foreign

Raj Nath Bhel, India; Richard Brett, England; Oswald G. Dellacanonica, Peru; Malcolm J. Nunney, England; Donald C. Paterson, Scotland; Raymond Poncet, France; Giuseppe Raiteri, Italy; Werner K. Strobel, Germany.


Five Advantages of TORCON
• A Complete Line of torque converters—from 15 up to 600 HP
• High Efficiency through wide range of 600 to 1700 rpm
• Hydra-Foil Blade—Clark-Torcon design: for effective multiplication, no cavitation
• Easy Accessibility for inspection and service; no special tools required
• Broadest Line of Options—readily adaptable to any torque transmission system; matched to almost any source of power for greatest efficiency and economy
It's another practical proof that it's good business to do business with Clark
CLARK® EQUIPMENT
CLARK EQUIPMENT COMPANY • BUCHANAN • Battle Creek, Jackson and Benton Harbor, Michigan

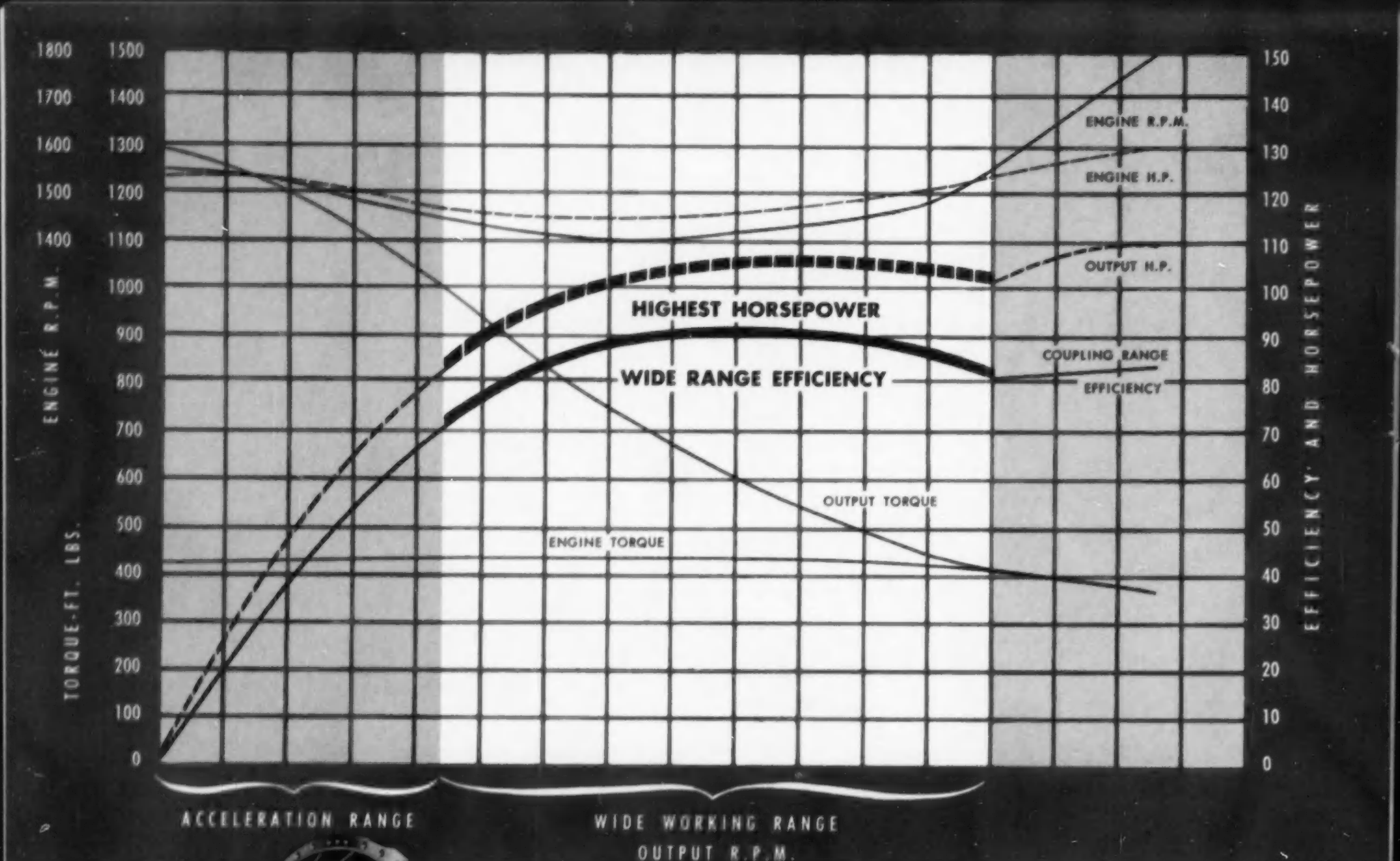


Chart Efficiency Curve 600 to 1700 rpm

TORCON

Torque Converters

offer high efficiency over wider working range . . USE *more of your horsepower more of the time.*

Here is a complete line of high quality torque converters, distinguished for uniform high efficiency over wide working ranges.

The Torcon "package" is a standard unit, mass-produced, available with a pump, cooler and pressure regulator. It is available off-the-shelf to engine and original equipment manufacturers, as well as to owners and operators seeking to modernize their equipment. With a wide range of wheel diameters and a complete line of options, the Torcon unit can be fitted easily and effectively into practically any torque-transmission system.

Without fail, check the Torcon quality features listed here; and consult Clark-Torcon engineers for experienced aid in planning your torque converter application. Write for full information.

CHECK THESE BASIC QUALITY FEATURES OF THE TORCON LINE

- **High efficiency over wide range**—produces more work and reduces wear on components.
- **True Hydro-foil blade**—best for torque multiplication; eliminates turbulence and resulting efficiency loss.
- **Most accessible unit**—inspection plates easily accessible; no special tools needed for service.
- **Self-contained oil circuit**—sump is an integral part of unit. Oil passages cored in housing—no unnecessary fittings or hoses; no leakage, no external oil seals under pressure.
- **Individually cast single-piece elements**—no welds or fabrications to distort under extreme loads.
- **A complete line**—15 to 600 H.P.
- **Broadest line of options**—readily adaptable to a wide range of applications.
- **Self-contained unit**—makes for simple installation.

CLARK EQUIPMENT

CLARK EQUIPMENT COMPANY
JACKSON, MICHIGAN

Firmly Established as the Buy of the Year!

It doesn't take Americans long to recognize a good thing. Look around you at the record-breaking number of Pontiacs on the road.

Notice how Pontiac's exclusive Twin-Streak styling and Vogue Two-Toning set it apart as 1955's most distinctive car.

Behind the wheel you'll discover Pontiac performs even better than it looks. You'll discover its mighty 180-horsepower Strato-Streak V-8 (200 horsepower with 4-barrel carburetor*) is so nimble and so responsive you're on even terms with *any* car on the road.

Its long 122″ or 124″ wheelbase cradles you in the same luxurious comfort enjoyed by those who buy at the top of the price scale. And as for maneuverability and handling, you're right in the sports car class.

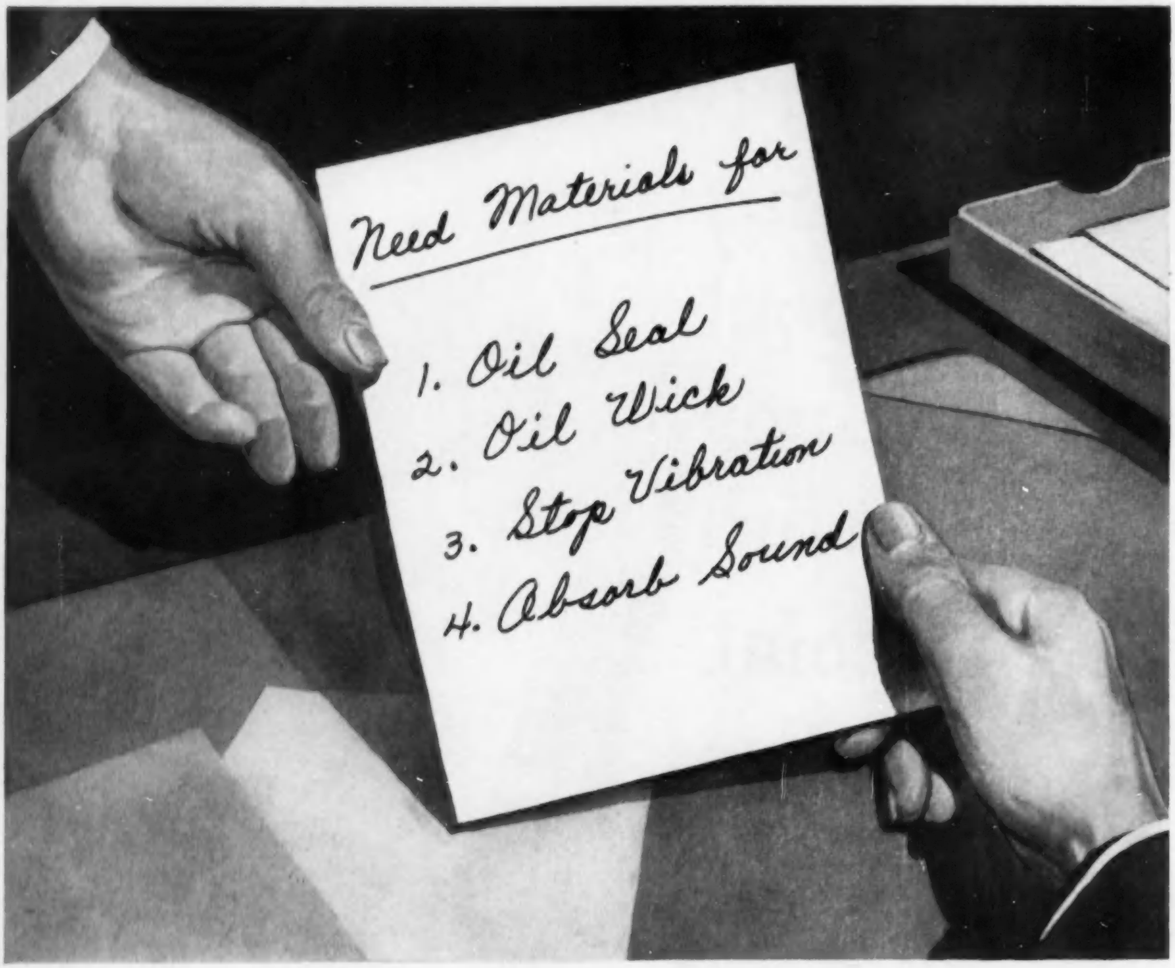
Now consider Pontiac's greatest "exclusive" —its unbelievably low price!

You can buy a big, powerful Pontiac for less than many models of the lowest-priced cars! No wonder you see more new Pontiacs than ever! See your Pontiac dealer for the facts and figures. Do it today and drive the buy of the year!

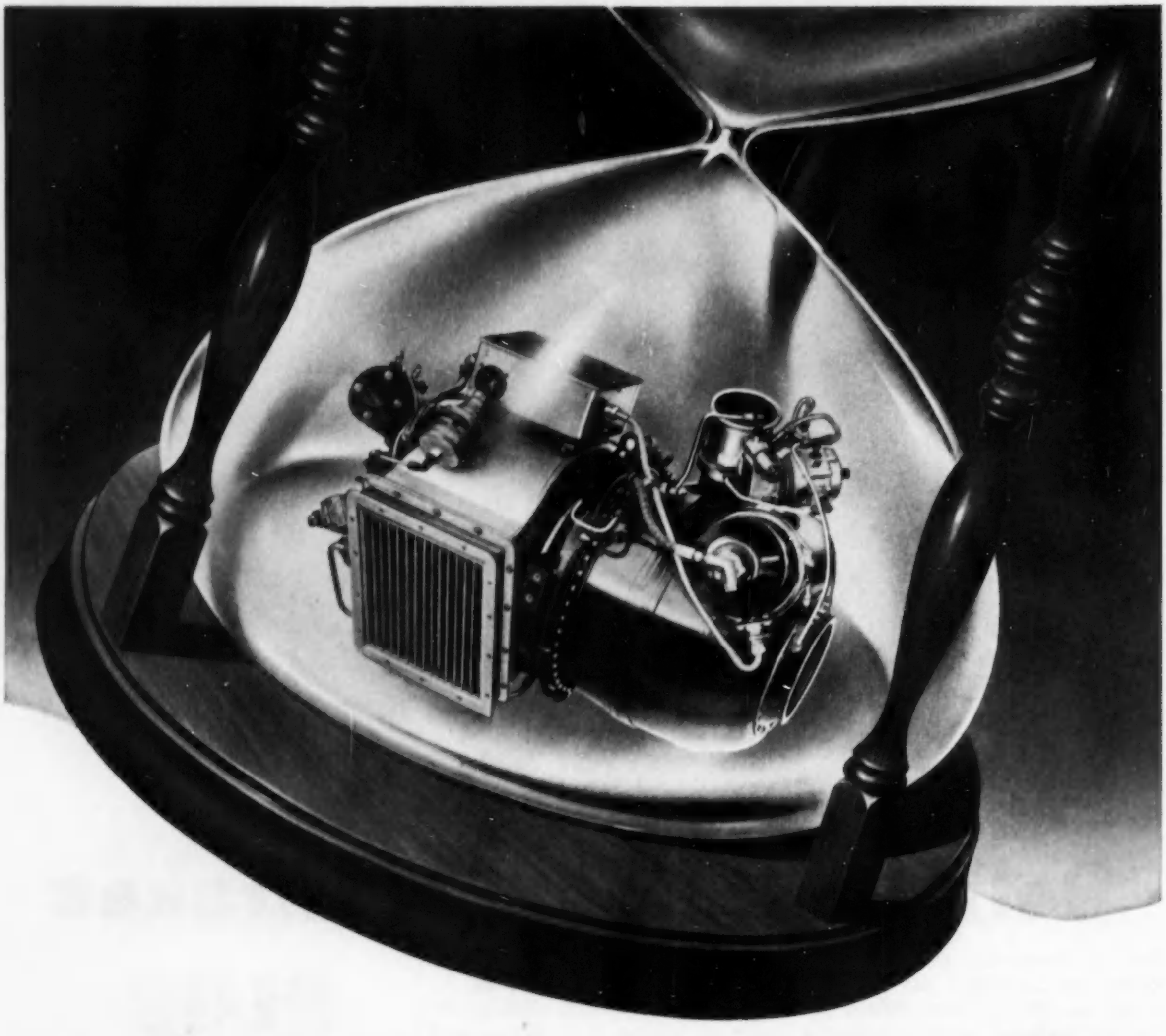
*Optional at extra cost.

Pontiac

PONTIAC MOTOR DIVISION OF GENERAL MOTORS CORPORATION



Need Materials for
1. Oil Seal
2. Oil Wick
3. Stop Vibration
4. Absorb Sound



Uniform high quality is the first requirement in automotive cable and cable assemblies. Packard cable *exceeds* SAE specifications, and meets or exceeds the high standards of automotive manufacturers. But Packard's advantages go beyond quality itself. Dependable, on-time delivery that results from flexible, carefully maintained production schedules is one of many additional benefits you enjoy when you deal with Packard.

Consider Packard as a source

When you choose Packard Electric as a source you acquire the services of an expert team that is familiar with all phases of the cable business. A daily production capacity of 7,000,000 feet of cable and more than 800,000 wiring assemblies assures unfailing delivery. And Packard's large staff of experienced engineers is at your service for expert counseling and advice at any stage of a job. In the past, benefits like these have meant big savings to many Packard customers. More than likely, they will mean the same to you.

GM GENERAL MOTORS

Packard

REG. U.S. PAT. OFF.

Packard Electric Division, General Motors, Warren, Ohio
Offices in Detroit, Chicago, and Oakland, California

AVIATION, AUTOMOTIVE AND APPLIANCE WIRING

ROADRANGER® provides annual fuel savings of $126.36 per tractor

Up to 43% faster trip time and average fuel savings of $126.36 per tractor annually were enough to convince Baltimore Transfer Company. They now specify Fuller R-45 Semi-Automatic ROADRANGER Transmissions for every new tractor purchased.

Baltimore Transfer and its wholly-owned subsidiary—Motor Freight Express—is ordering 48 International R-195 tractors per year, and expects to increase to 96 a year by 1957.

The Fuller Semi-Automatic ROADRANGER was tested by Baltimore Transfer on its own routes, under its own operating conditions, against conventional 5-speed transmissions with 2-speed rear axles. Both transmissions were installed in identical International R-195's, with identical loads.

On a stretch between Baltimore and Blue Mountain, Pa. (22 miles, over hilly terrain) the ROADRANGER-equipped tractor came in 27 minutes ahead of the tractor with the main-and-2-speed axle combination.

Through single-lever control of all forward speeds—and with all ratios evenly and progressively spaced—the Fuller Semi-Automatic ROADRANGER lets the driver select the right ratios at the right time, without having to tussle with gear splits or sit waiting on automatic actuation.

On *your* trucking operations, the result will be more speed on hills, steadier speed in traffic, lower fuel consumption and less engine maintenance. *See your truck dealer, ask him for full details on Fuller Semi-Automatic* ROADRANGER *Transmissions.*

where horsepower really goes to work

Fuller TRANSMISSIONS®

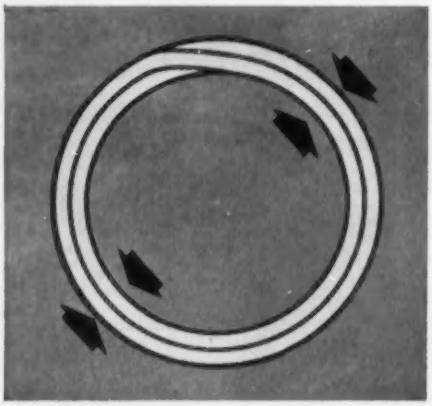
FULLER MANUFACTURING COMPANY (Transmission Division), KALAMAZOO, MICHIGAN

Unit Drop Forge Div., Milwaukee 1, Wis. • Shuler Axle Co., Louisville, Ky. (Subsidiary) • Sales & Service, All Products, West. Dist. Branch, Oakland 6, Cal. and Southwest Dist. Office, Tulsa 3, Okla.

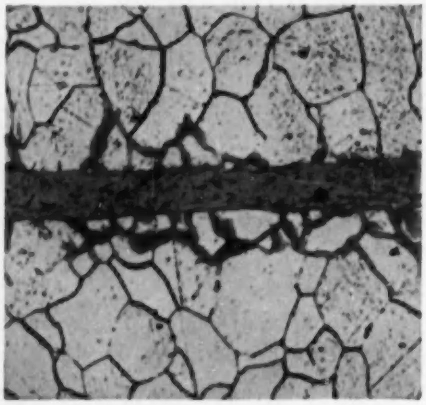
Only Bundyweld steel tubing

Here's why Bundyweld STEEL Tubing is used on 95% of today's cars

The illustrations below reveal why Bundyweld is specified by automotive manufacturers where strength and durability of tubing are essential. Bundyweld is the only tubing double-walled from a single metal strip. This exclusive process gives Bundyweld superior strength properties. Yet, because of the conditions under which Bundyweld is brazed and cooled, it is uniform and easy to fabricate.

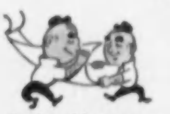


With Bundyweld's beveled edges and single close-tolerance strip, there's no inside bead. The tubing is uniformly smooth, both inside and out. It fabricates easily; can be bent to short radii. Copper coating, inside and out, facilitates soldering and brazing operations.



This view of Bundyweld's copper bond (enlarged 300 times) shows how the copper actually alloys with the steel . . . through 360° of wall contact. That's the secret of Bundyweld's outstanding resistance to high pressure and vibration fatigue.

WHY BUNDYWELD IS BETTER TUBING



Bundyweld starts as a single strip of copper-coated steel. Then it's . . .

continuously rolled twice around laterally into a tube of uniform thickness, and

passed through a furnace. Copper coating fuses with steel. Result . . .

Bundyweld, double-walled and brazed through 360° of wall contact.

←

NOTE the exclusive Bundy-developed beveled edges, which afford a smoother joint, absence of bead, and less chance for any leakage.

Tomorrow's oil seal here today in Victor Silicones

Type K-6 Dual Lip Silicone Pinion Seal with Flange

Patent 2172325—Sept. 5, 1939
Patent 2233902—Mar. 4, 1941

Superior bonding of Victor silicones to metal channel permits a strong, one-piece, leakproof construction. Internal lip retains lubricant; external lip excludes foreign matter. Valley in between the sealing lips is pre-lubricated for minimum friction. Cartridge-type flange allows ready removal of seal from housing without damage.

Here's the oil seal that makes a complete break with yesterday's sealing elements of tired leather, leather with additives . . . even steps out far ahead of synthetic rubber.

Here, Victor-developed silicones start a new era of automotive sealing progress, in highly engineered designs for tomorrow's tougher, more exacting needs. Tested as original equipment since 1953, Victor Silicone Seals were the first of their kind to merit approval by the auto industry.

Advantages of silicones, found in Victor's earliest pioneering of these compounds, have been developed to the finest degree. Their suitability for high temperatures beyond 300 deg. F., and for high peripheral speeds, measurably exceeds that of conventional materials. They work well with the new lubricants. Throughout life, the element remains flexible and operative, does not harden or get brittle.

These premium seals can now be specified in the competitive market. Victor's skill in manufacturing—as in development—has led the way to large-quantity production at prices consistent with performance values. Your inquiry is invited.

VICTOR Silicone Oil Seals

Victor Mfg. & Gasket Co., P. O. Box 1333, Chicago 90, Ill.

Sealing Products Exclusively • Oil Seals • Gaskets • Packings


DON'T
COMPROMISE
FOR JUST
A BEARING
—be sure
it is THE
bearing!
"THE BEARING" will probably be a Johnson Sleeve Bearing, designed specifically for the application. There are several important factors involved in the selection of the correct bearing for any job . . . principally service conditions. Operating speed, temperatures, corrosive conditions, load, shock . . . all must be carefully considered. Since Johnson Bronze produces all types of sleeve bearings, uses all types of bearing metals, their engineers will give you unbiased advice and will assist you in designing the correct sleeve bearing for your application. Write, wire or phone for an appointment with a Johnson Bearing Specialist.
JOHNSON BRONZE COMPANY
675 South Mill St., New Castle, Pa.
BRONZE-ON-STEEL
—copper lead
STEEL BACK
—babbitt lined
BRONZE BACK
—babbitt lined
CAST BRONZE
ALUMINUM ALLOY
LEDALOYL
—powder metallurgy
JOHNSON JB BEARINGS
Sleeve-Type
SLEEVE BEARING HEADQUARTERS SINCE 1901

450°F Tachometer Generator

meets modern jet engine requirements

Military specification numbers as used herein are for purposes of product identification only and do not necessarily imply specification conformity.

For use on high performance jet aircraft, the new Jack & Heintz Model H60-164 is a two-pole tachometer generator designed to meet MIL-G-9398.

By utilizing special design elements, this generator operates accurately at the higher altitudes and critical heat associated with advanced flight. It provides reliable and accurate engine speed indication not attainable through the use of present conventional units at a temperature of 450° F.

The special design features which enable J & H to give this performance are:

1. Heat-treated, magneto-type ball bearings.
2. Teflon-insulated magnet wire.
3. Wide temperature range greases for operation from −90° F to +525° F. *The new J & H unit has a breakaway torque of only 1 to 2 inch-pounds after 48-hour soak at −90° F as contrasted to the specified 12 inch-pounds.*

In the past five years, Jack & Heintz has supplied over 100,000 small, lightweight, permanent-magnet a-c tachometer generators to the Military, aircraft engine and accessory manufacturers and commercial airlines. The entire product line includes *sensing units* and *power sources* for:

1. Rpm indication
2. Propeller synchronization
3. Aircraft engine analyzers
4. Electronic jet-engine fuel controls
5. Turbine power packages

Whether you want a tachometer generator or any type of small permanent-magnet a-c generator, look to J & H for the answer. For complete information, write Jack & Heintz, Inc., 17638 Broadway, Cleveland 1, Ohio. Export Department: 13 East 40th Street, New York 16, N. Y.

ENGINEERS: Write for free booklet describing unusual opportunities for you at Jack & Heintz.

JACK & HEINTZ *Rotomotive* **AIRCRAFT EQUIPMENT**

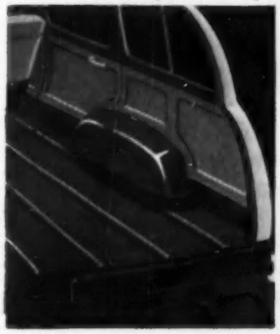
Here's reinforced VIBRIN...in sport car bodies

• DENT-PROOF • RUST-PROOF • ROT-PROOF
• STRONGER THAN STEEL BY WEIGHT • EASILY MOLDED TO COMPLEX CONTOURS
• SOUND DEADENING • RESISTANT TO OIL AND GAS • UNHARMED BY WEATHER

WHY NOT reinforced Vibrin...?

... seat frames

... station wagon flooring



... motorcycle sidecars

Seat frames of reinforced Vibrin could easily be molded in one assembly-saving piece... to body-cradling contours. They'd help eliminate spring squeak... or, with foam rubber, eliminate springs altogether. And they'd save weight, too.

Station wagon flooring of tough reinforced Vibrin could be molded in one large piece to eliminate dirt-catching cracks. It would never rust, never need painting... and would insulate against both heat and rattle. What's more, it would take all kinds of rough wear, could be ribbed to support practically any weight.

Motorcycle sidecars of this same material could be formed to any streamlined shape. The unusually light weight would facilitate removal of the sidecar assembly when desired. And they'd be natural heat insulators... and always pleasant to the touch.

Why not? Why not reinforced Vibrin *dashboards, roof frames for convertibles, splash pans, fender skirts?* Remember, industry is only *beginning* to take advantage of the unique properties this new material offers.

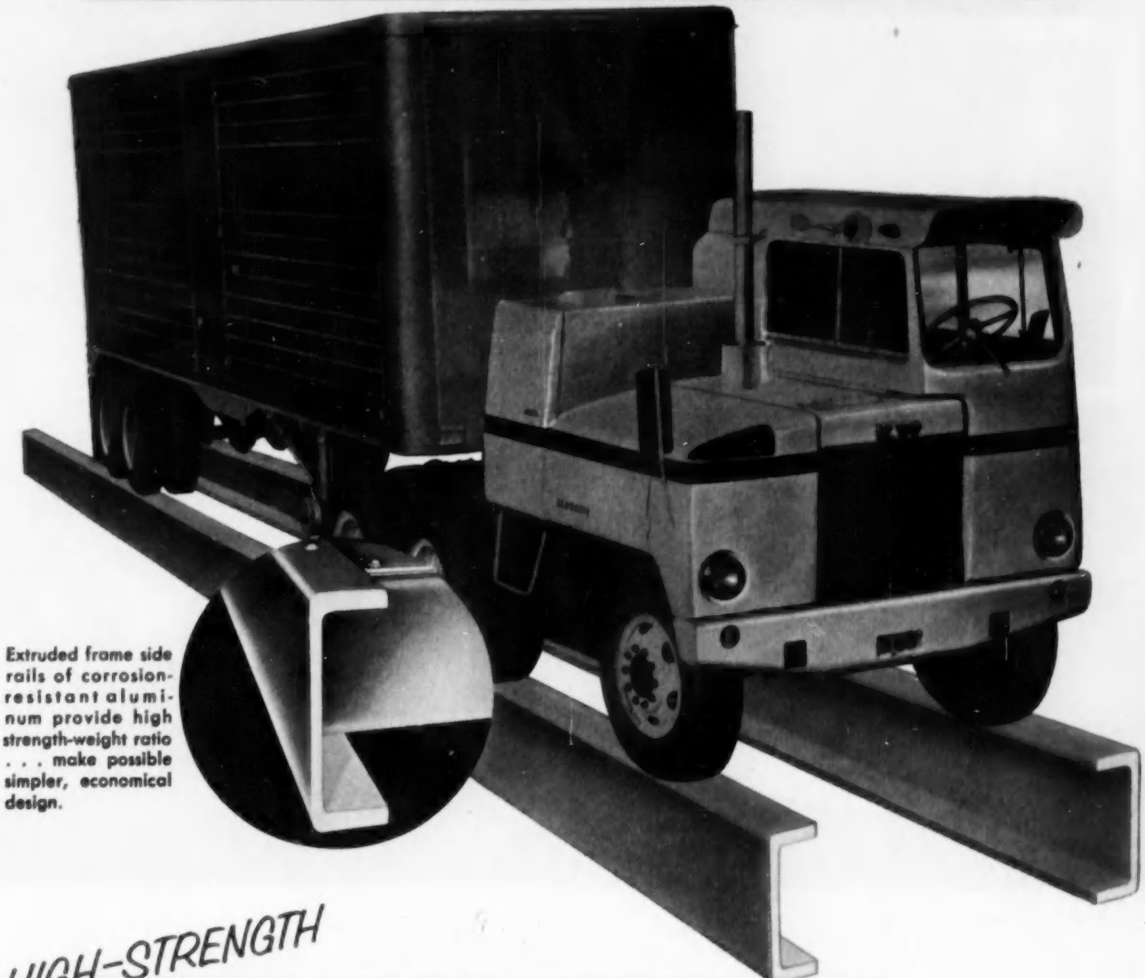
You'd better explore the *many* advantages reinforced Vibrin offers *you*, by writing for more information today.

Naugatuck Chemical

Division of United States Rubber Company
Naugatuck, Connecticut

BRANCHES: Akron • Boston • Charlotte • Chicago • Los Angeles • Memphis • New York • Philadelphia • IN CANADA: Naugatuck Chemicals, Elmira, Ontario
Rubber Chemicals • Synthetic Rubber • Plastics • Agricultural Chemicals • Reclaimed Rubber • Latices • Cable Address: Rubexport, N.Y.

600 LBS. SAVED FOR PAYLOAD



Extruded frame side rails of corrosion-resistant aluminum provide high strength-weight ratio . . . make possible simpler, economical design.

HIGH-STRENGTH

Bridgeport Aluminum Extrusions are the backbone of Kenworth's new truck design

Kenworth Motor's revolutionary Cab-Beside-Engine construction is strictly functional . . . designed to achieve maximum driver visibility . . . easier access to engine for maintenance and greatly reduced weight.

Supporting this new design are light, strong aluminum extrusions used for the frame side rails. These custom shapes – produced by Bridgeport – reduce fabricating costs and save an impressive 600 lbs. over a steel frame. *All this without any sacrifice in strength or safety!*

For your structural members, consider the economy and unlimited design possibilities of aluminum extrusions. Then look to Bridgeport as a dependable source of supply. Our experience in working closely with customers can be profitable to you in achieving an economical, practical design. Our fully integrated production facilities enable us to produce the die and extrude the shape to your exact specifications.

Get in touch with your nearest Bridgeport Sales Office for more information on engineering and technical services available to the transportation industry.

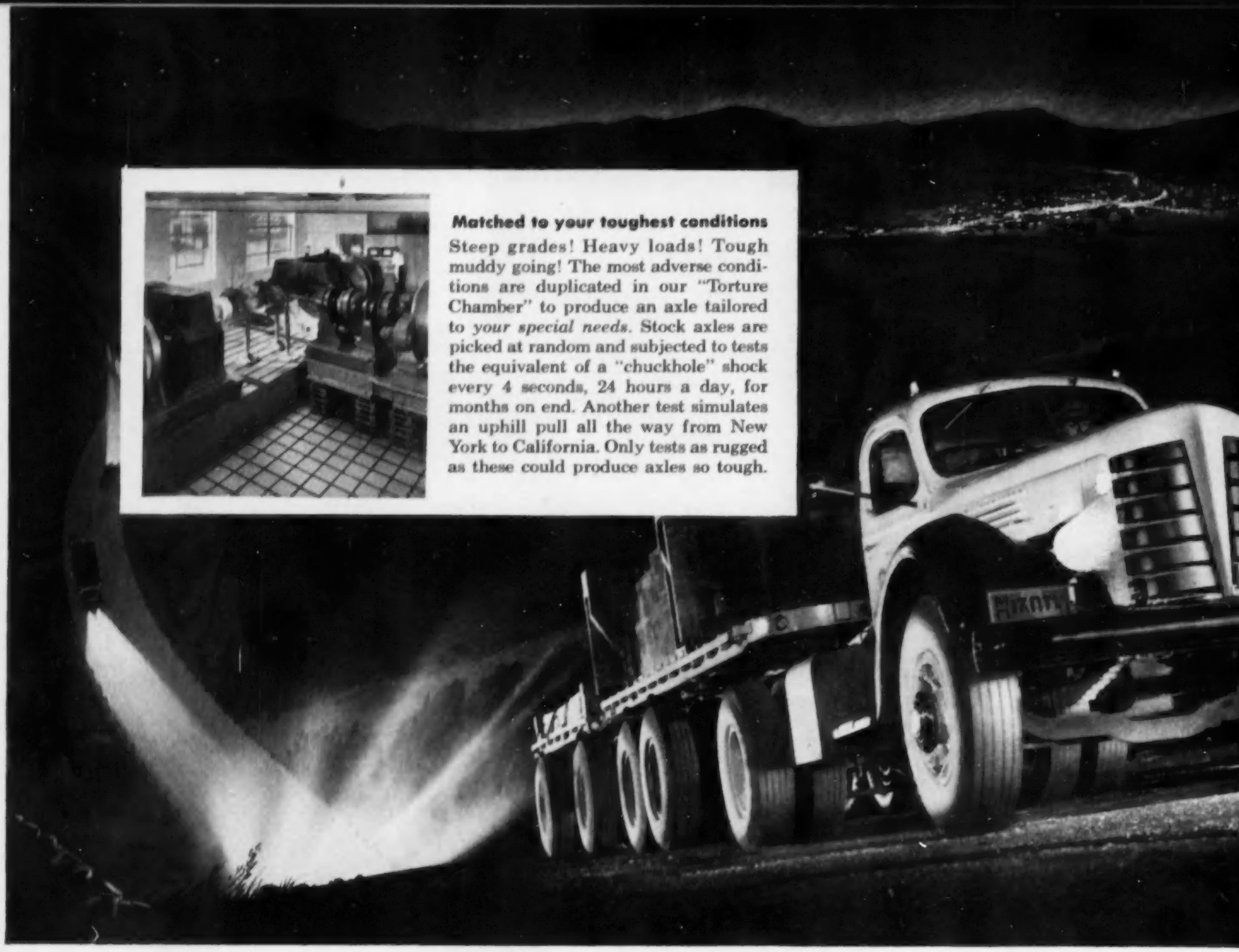
For the very latest in

BRIDGEPORT ALUMINUM

EXTRUSIONS, DIE AND HAND FORGINGS

Bridgeport Brass Company, Aluminum Division, Bridgeport 2, Connecticut

Offices in Principal Cities



GREATEST ADVANCE SINCE

exclusive double-reduction design 2-speed gear ratio spread!

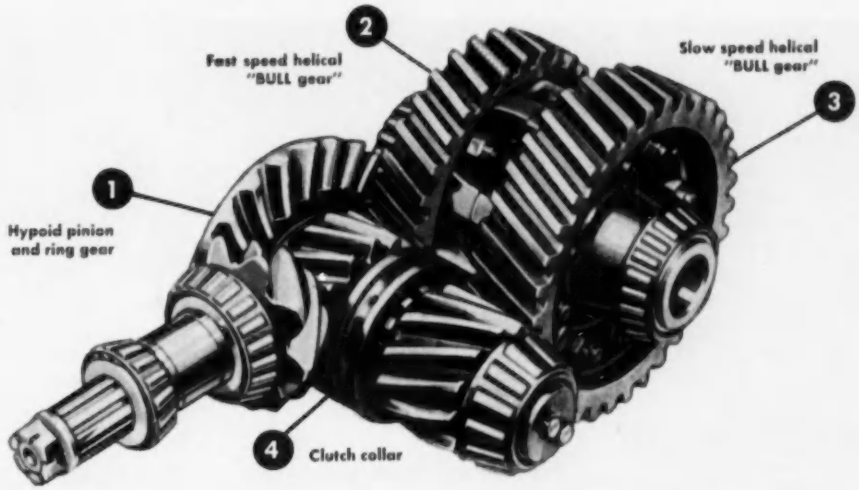
Tailor-made power exactly to your trucking needs with Timken-Detroit!

Unequalled flexibility! TDA 2-Speed Axles, give an almost *unlimited* choice of gear ratios. The Timken-Detroit design is so simple and basic, that an ordinary mechanical change lets you tailor power exactly to your trucking needs. Where other 2-speed axles limit you to only a single gear spread of 37%, TDA offers a range all the way from 28% to 49%.

TDA meets varied needs! The variety of hauling conditions that today's trucks must meet call for maximum speed and power flexibility. Other 2-speed axles are just too limited to meet this need. On the other hand, TDA's simple double reduction design gives complete flexibility. Gear ratio can be easily changed without weakening the axle unit in any way.

How you benefit! TDA not only gives you a much wider power range, but also, all the advantages of a stronger, sturdier, smoother operating design. Since helical "Bull" gear sets operate independent of one another, there is no overheating even after indefinite running in low speed. Bigger huskier TDA parts last longer, stand up better under tough usage.

Less down-time, longer axle life, fewer repairs, higher fuel economy, lower operating costs and higher profits. These are some of the important reasons why so many leading manufacturers and operators everywhere specify Timken-Detroit 2-Speed Axles.



How the exclusive double-reduction design of

TDA 2-SPEED AXLES

gives you greater speed, endurance, and economy!

This is HOW TDA's 2-Speed principle works! A husky hypoid ring gear and a bigger, stronger pinion set (No. 1 in illustration above) provide the *first step* of the total gear reduction for both fast and slow ratios. Two large, heavy-duty helical gear sets provide the *second step*. Both sets are of balanced size and capacity. One set (No. 2 in illustration) is for fast speed; the other (No. 3) is for slow speed. The clutch collar (No. 4) moves to right or left to engage one helical pinion or the other.

WHY this principle offers far wider spread! Because the TDA design is so simple, the ratio may be changed merely by changing the low speed helical gear pinion. Unlike ordinary designs which are limited to 37%, TDA offers spreads of 28%, 37%, and 49%. In effect, this flexibility gives you your choice of power ratios to exactly match your needs.

Greater endurance, longer truck life with TDA. TDA's simple design eliminates small complicated parts and midget size gears. Large hypoid helical design gives more teeth in contact – quieter operation and far less strain. Bearings are larger, too. Helical "Bull Gears" not in use idle, further reducing wear. All this adds up to longer engine life . . . and more efficient and profitable operation under all conditions.

THE FIRST 2-SPEED AXLE

gives TDA world's widest

TIMKEN *Detroit* AXLES

TIMKEN-DETROIT AXLE DIVISION

ROCKWELL SPRING AND AXLE COMPANY

DETROIT 32, MICHIGAN

The Accepted TDA Standard

TRADE MARK REGISTERED

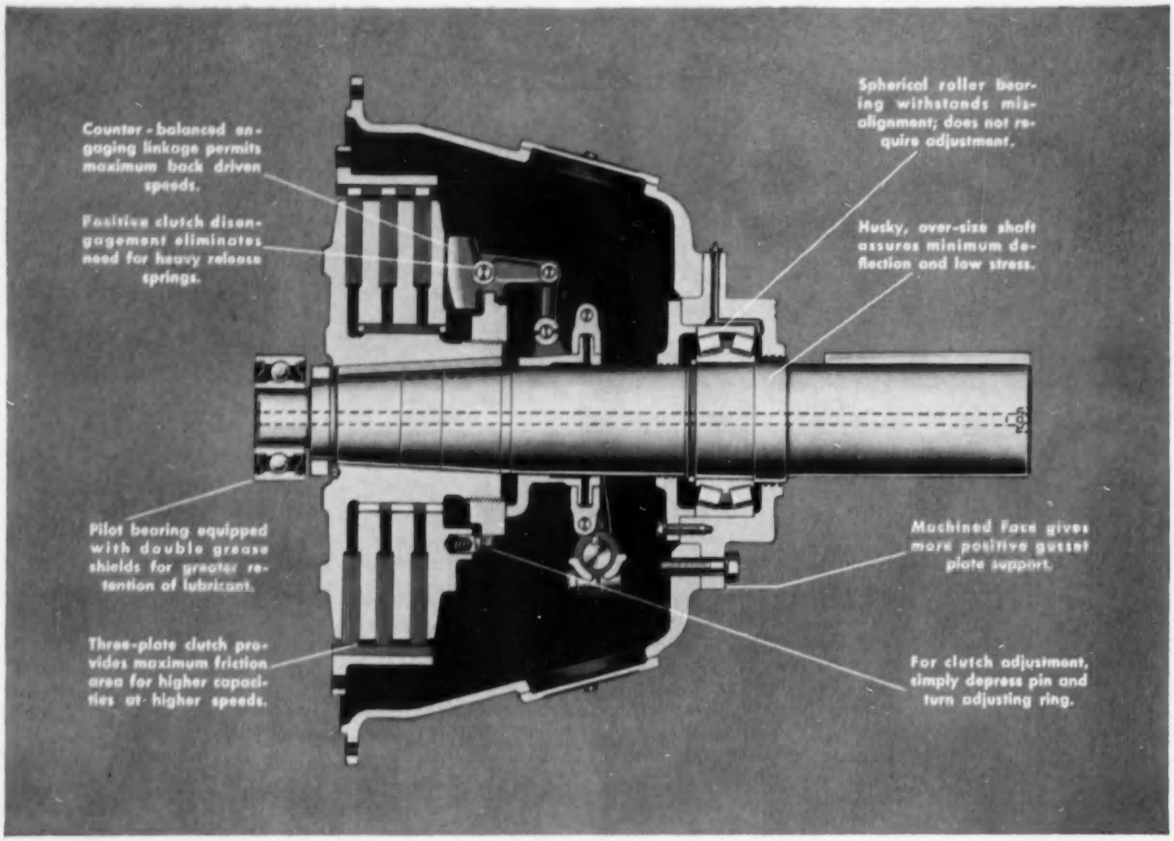
World's Largest Manufacturers of Axles for Trucks, Buses and Trailers

Plants at: Detroit, Michigan • Oshkosh, Wisconsin • Utica, New York • Ashtabula, Kenton and Newark, Ohio New Castle, Pennsylvania

Increase axle life with GENUINE TDA EQUIPMENT PARTS

Take no chances with ordinary replacement parts. For sure, dependable factory-type jobs, specify genuine Timken-Detroit axle parts kits—identical to your axles' original equipment.

Each kit is complete — gives you everything you need in one handy package. Gaskets and shim parts, brake liners, steering knuckles, differential gears — for every size of brake and axle. Order by number from your dealer. Cut labor and adjustment costs. Get trucks back on the road quicker.



A new Power Take-Off for higher-speed, higher-horsepower engines

Here is the all-new Twin Disc Model SP-318 heavy-duty Friction Power Take-Off—designed and engineered especially to meet the extra requirements of the new engines in the 350 to 375 hp range, operating up to 1800 rpm.

Extremely compact for its capacity, the new Twin Disc Power Take-Off is provided with an S.A.E. #0 flywheel housing. With triple driving plate construction, it assures ample friction surfaces to withstand high horsepower loads. And with solid driving plates, the new PTO effectively permits higher safe permissible speeds.

The pilot bearing of the new Power Take-Off is composed of a single row of balls, operating in bearing races of double-row width . . . providing improved accommodation of minor misalignment inherent in installations of this nature. Pilot bearings of this type provide additional space for lubricant, which is more effectively retained by the double grease shield construction. Although this construction is usually referred to as "sealed for life," the clutch shaft is drilled to provide for relubrication of the pilot bearing in the usual manner.

Another outstanding feature of the new Twin Disc Power Take-Off is the use of a spherical bearing which does not require adjustment. With its inherent ability to permit angularity, the spherical bearing is more resistant to overload and destructive forces resulting from heavy side loads.

For complete information on the new Twin Disc SP-318 Friction Power Take-Off (and the SP-314, a smaller model of the same new design, for engines in the 225 hp range operating at 2200 rpm), write to the Twin Disc Clutch Company, Racine, Wisconsin.

TWIN DISC

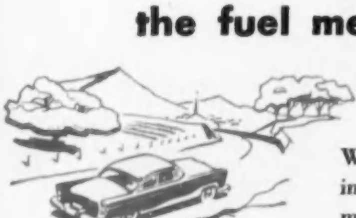
TWIN DISC

Friction Clutches and Fluid Drives

TWIN DISC CLUTCH COMPANY, Racine, Wisconsin
Hydraulic Division, Rockford, Illinois

BEARINGS CGB BUSHINGS
WORLD'S LARGEST PRODUCER
OF SLEEVE BEARINGS
AND BUSHINGS
Our Design Engineers
are at your service
THE CLEVELAND GRAPHITE BRONZE COMPANY
A DIVISION OF CLEVITE CORPORATION
SALES OFFICES AT CLEVELAND, DETROIT, NEW YORK AND CHICAGO

How Holley's rolling laboratories test the fuel metering devices for tomorrow's cars and trucks



When a carburetor prototype or an important design change has proven its merit at Holley's "inside" research lab, it's sent to the world's toughest proving ground—the streets and highways of America.

Holley's inside research and development laboratory—one of the best equipped in the automotive industry—can tell only part of the story. Cold room, dynamometer, and air box testing simulate to a high degree the driving conditions a carburetor prototype will ultimately face. Even before these physical tests, an electronic computer—Holley acquired one of the first in the automotive industry—checks and tabulates design theory from drawing board specifications.

But ultimately, the most conclusive test is found on city streets, country roads and super highways. Holley engineers frequently average 500 miles a day for ten days measuring a carburetor's performance in heavy traffic or on super highways.

The results of this concentration on research both "inside" and "outside" have helped to bring Holley equipped cars 5 sweepstakes champions in Mobilgas Economy Runs and 3 straight Heavy Stock Car winners in the fabulous Pan American Road Race.

HOLLEY Carburetor Co.

FOR MORE THAN HALF A CENTURY—ORIGINAL EQUIPMENT MANUFACTURERS FOR THE AUTOMOTIVE INDUSTRY.

11955 E. NINE MILE ROAD, VAN DYKE, MICHIGAN

R/M

FIRST IN FRICTION

HOW R/M ENGINEERING SETS

Illustrated above are just a few of the friction parts made by R/M for operation in oil. The wide variety of sizes and shapes suggests the tremendous scope of R/M experience in solving specialized application problems in this field.

THE RECORD OF "FIRSTS" IN FRICTION MATERIAL DEVELOPMENT SHOWS WHY R/M IS FIRST IN FRICTION

FIRST Woven Brake Lining • FIRST Asbestos Brake Lining • FIRST Ground Wearing Surface • FIRST Zinc Alloy Wire Brake Lining • FIRST Pre-Treated Yarns • FIRST Extruded Pulp Brake Lining • FIRST Flexible Pulp Brake Lining in Rolls • FIRST Dry Process Brake Lining • FIRST Semi-Metallic Brake Lining • FIRST Bonded-to-Metal Brake Lining • FIRST Woven Clutch Facings • FIRST Molded Asbestos Clutch Facings for Clutches Operating in Oil FIRST Endless Woven Clutch Facings • FIRST Pre-Treated Clutch Facings • FIRST Bonded-to-Metal Clutch Facings


1898
manufacturers of Ball Bearings for the automotive industry since 1898.
MRC
MRC
MRC
1955
MARLIN-ROCKWELL CORPORATION
Executive Offices: Jamestown, N.Y.
Factories: Jamestown, N.Y. Plainville, Conn. Falconer, N.Y.

To our Favorite Boss!

From the receptionist at the front door through to the last man on the loading platform—*all* of us here at Great Lakes Steel have a very important *something* in common. It is the knowledge that your continued and expanded need for our products determines the future and growth of every one of us, regardless of our individual jobs here.

It is the knowledge that *you*, Mr. Customer, are the boss!

That's why we at Great Lakes are seeing to it that our steel is the kind you have a right to expect from a specialist in flat-rolled products. We know the importance of prompt shipments, top quality, proper packaging and loading, dependable information, and clerical accuracy. We think you'll agree that our many satisfied customers are a pretty good indication that this policy is good business for all concerned.

Next time you have a problem in steel, call on one of our representatives to help you solve it. You'll be glad you did!

GREAT LAKES STEEL CORPORATION
Ecorse, Detroit 29, Mich. • A Unit of
NATIONAL STEEL CORPORATION

SALES OFFICES IN BOSTON, CHICAGO, CINCINNATI, CLEVELAND, HOUSTON, INDIANAPOLIS, LANSING, LOS ANGELES, NEW YORK, PHILADELPHIA, PITTSBURGH, ROCHESTER, ST. LOUIS, SAN FRANCISCO AND TORONTO


OIL FILTERS
The many new developments and steady progress evidenced by WIX make this company an attractive source for both fuel and lube oil filters and cartridges of every size and filtration principle. WIX has years of successful O.E.M. experience with important companies. Alert management, sound financial structure, fine earning record, abundant capacity . . . imaginative, cooperative engineering and merchandising.
Write!

Maximum Rust Protection

and a fine black finish for iron and steel

This long-wearing, rust resistant product is used on many types of iron and steel articles: Nuts and bolts, brackets, screws, nails, springs; tools, casters, padlocks, machine housings and castings; outdoor furniture, hinges, latches, ornamental iron.

Parco Compound is a versatile metal treatment. It is simple to operate, easy to control, dependable and uniform in results, and economical. It creates a dense coating of nonmetallic phosphate crystals over the whole surface of the article treated. There are no limitations on size or shape—any article which can be immersed in the tank can have this protection. Oil, wax, stain, or paint finishes may be used over Parco Compound, to produce maximum rust resistance with deep, velvet black appearance.

Write for complete information!

Since 1915—leader in the field

**Bonderite, Bonderlube, Parco, Parco Lubrite—Reg. U.S. Pat. Off.*

PARKER
RUST PROOF COMPANY

2181 East Milwaukee, Detroit 11, Michigan

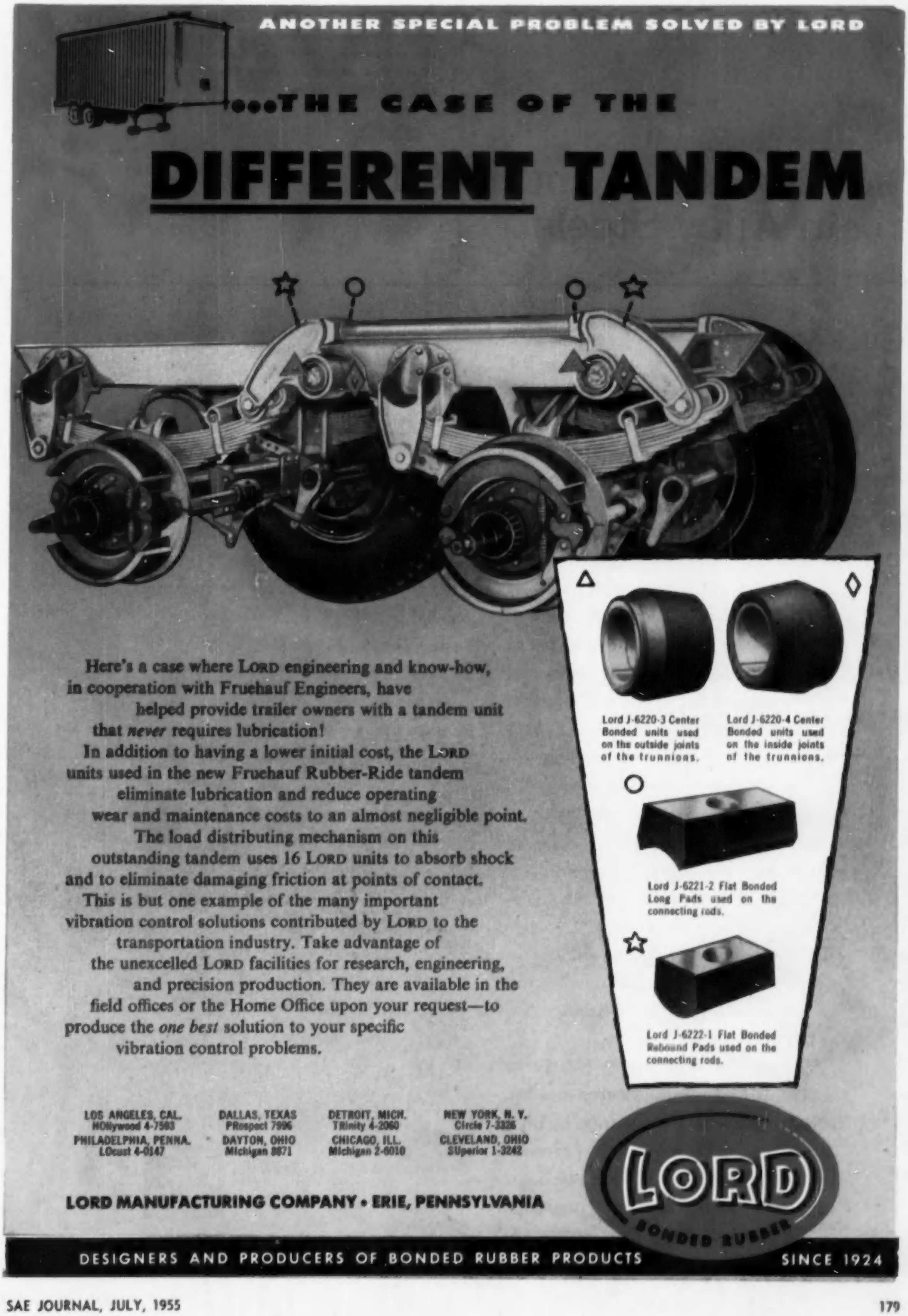
PARCO COMPOUND — rust resistant

PARCO LUBRITE — wear resistant for friction surfaces

BONDERITE — corrosion resistant paint base

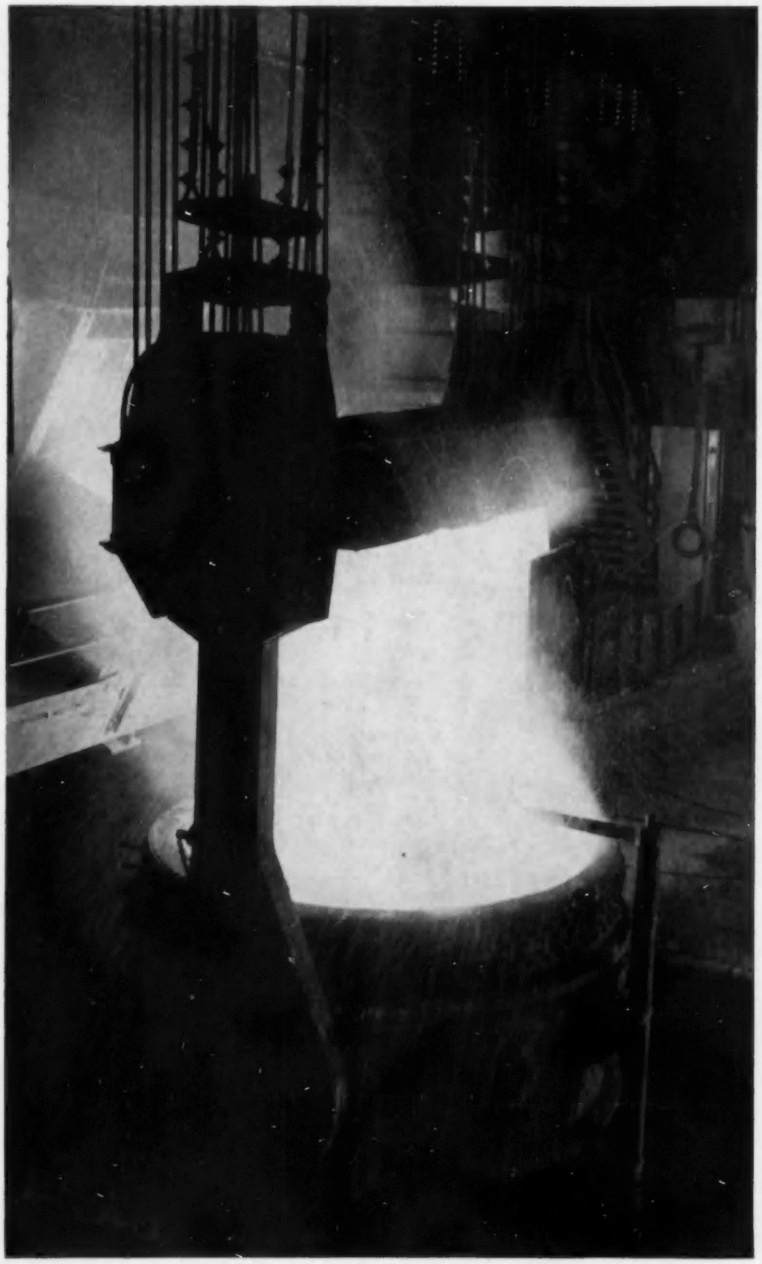
BONDERITE and BONDERLUBE — aids in cold forming of metals

TROPICAL — heavy duty maintenance paints since 1883



ANOTHER SPECIAL PROBLEM SOLVED BY LORD
...THE CASE OF THE
DIFFERENT TANDEM
Lord J-6220-3 Center Bonded units used on the outside joints of the trunnions.
Lord J-6220-4 Center Bonded units used on the inside joints of the trunnions.
Lord J-6221-2 Flat Bonded Long Pads used on the connecting rods.
Lord J-6222-1 Flat Bonded Rebound Pads used on the connecting rods.
Here's a case where LORD engineering and know-how, in cooperation with Fruehauf Engineers, have helped provide trailer owners with a tandem unit that *never* requires lubrication!
In addition to having a lower initial cost, the LORD units used in the new Fruehauf Rubber-Ride tandem eliminate lubrication and reduce operating wear and maintenance costs to an almost negligible point.
The load distributing mechanism on this outstanding tandem uses 16 LORD units to absorb shock and to eliminate damaging friction at points of contact.
This is but one example of the many important vibration control solutions contributed by LORD to the transportation industry. Take advantage of the unexcelled LORD facilities for research, engineering, and precision production. They are available in the field offices or the Home Office upon your request—to produce the *one best* solution to your specific vibration control problems.
LOS ANGELES, CAL. HOllywood 4-7593
PHILADELPHIA, PENNA. LOcust 4-0147
DALLAS, TEXAS PRospect 7996
DAYTON, OHIO Michigan 8871
DETROIT, MICH. TRinity 4-2060
CHICAGO, ILL. Michigan 2-6010
NEW YORK, N. Y. Circle 7-3326
CLEVELAND, OHIO SUperior 1-3242
LORD MANUFACTURING COMPANY • ERIE, PENNSYLVANIA
LORD
BONDED RUBBER
DESIGNERS AND PRODUCERS OF BONDED RUBBER PRODUCTS
SINCE 1924

We make our own fine alloy steel—and make it nickel-rich to make TIMKEN® bearings tougher



NICKEL makes steel tougher. So, our steel-making specialists don't skimp on nickel in the fine alloy steel we make for Timken® tapered roller bearings. They use exactly the right amount of nickel to give these bearings the toughness they need to withstand shock and last longer. Exacting quantities of chromium or molybdenum or both guarantee uniform hardness. By using the steel industry's first direct-reading spectrometer, we exercise hairline control of each element at the precise instant of tapping the furnace.

Rolling, annealing, and cooling are done with the same meticulous care. And every race and roller that goes into a Timken bearing is precision case-carburized to give it a hard, wear-resistant surface over a tough, shock-resistant core.

We've been specializing in the production of fine alloy steel for almost forty years. We're the only bearing manufacturer in the country that makes its own steel, because it's the only way we can make sure the quality of our bearing steel is just the way we want it. Steel is the heart of the bearing. That's why we insist on controlling bearing quality *every* step of the way—from melt shop to final bearing inspection. And that's why we don't skimp on the use of nickel.

To be absolutely sure of the highest performance standards in the equipment you build or buy, always specify Timken tapered roller bearings. They are made from seamless tubing or forgings by the most modern processes, under strict control. Only Timken bearings roll so true, have such quality thru-and-thru. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.

Only **TIMKEN®** bearings roll so true, have such quality thru-and-thru